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Chronological Contexts of the Earliest Pottery Neolithic in the South Caucasus: Radiocarbon Dates for Göytepe and Hacı Elamxanlı Tepe, Azerbaijan

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Research on the earliest Neolithic in the South Caucasus is still in its early stages. Establishing a solid chronological framework will help determine the timing of the emergence and subsequent development of regional Neolithic societies. This article reports on 46 radiocarbon dates obtained from the two recently excavated Early Pottery Neolithic sites of Göytepe and Hacı Elamxanlı Tepe, the oldest farming villages known to date in West Azerbaijan. Comparing the dates from other related sites demonstrates that several settlements representing the earliest Pottery Neolithic emerged almost simultaneously at the beginning of the sixth millennium B.C.E. in the northern and southern foothills of the Lesser Caucasus Mountains. The lack of evidence for plant cultivation or animal husbandry at earlier sites suggests a foreign origin for agricultural economies in the South Caucasus. However, cultural items characterizing the initial agropastoral communities were not brought to the region as a package. Instead, we suggest that these early farming communities—that is, the Shomutepe-Shulaveri—underwent gradual but significant autochthonous developments likely deriving from the aceramic stage. The chronological framework provided by Göytepe and Hacı Elamxanlı Tepe serves as a reference point for identifying details of early farmers' cultural developments in the South Caucasus.[1]

INTRODUCTION: ISSUES SURROUNDING NEOLITHIZATION IN THE SOUTH CAUCASUS

Archaeological research over the last few decades has shown that the first Neolithic societies developed as early as the 10th to ninth millennia B.C.E. in the Middle East, particularly in regions on the southeastern flanks of the Anatolian Mountains and farther south.[2] While the details of these initial Neolithization processes need further clarification, current research is also being directed toward understanding the processes that took place in

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[2] See, e.g., Zeder 2008, 2011; Willcox 2013.

neighboring regions and their relationship with the Neolithization processes in the Middle East. The most thoroughly studied issue has clearly been the dispersal west toward Europe, whereas our understanding of when and how Neolithic societies emerged in the northern, eastern, and southern regions is less satisfactory.[3] The South Caucasus represents one such region holding the potential for more intensive investigations into these matters.

The first goals must be to securely define the cultural remains associated with subsistence records and to clarify the chronology of Neolithic settlements in the region. Research in the 1960s and 1970s revealed the existence of fully fledged agricultural settlements in the South Caucasus—notably, along the Araxes and Kura Valleys.[4] Excavations at sites such as Shomutepe and Shulaveris Gora led to the recovery of circular mudbrick buildings and typical Pottery Neolithic materials (defined as the Shomutepe-Shulaveri culture),[5] including groundstones and domesticated plants and animals. Although these early finds led some authors to suggest links with northern Mesopotamia at the onset of the farming economy in the region,[6] the view has long remained a mere suggestion. Even the chronological position of these earliest agricultural settlements has been left uncertain, although a period from the fifth to fourth millennia B.C.E. was originally proposed based on uncalibrated radiocarbon dates, many of which were derived from uncertain archaeological contexts.[7]

Another important goal should be to interpret relations in the cultural and socioeconomic spheres between the Shomutepe-Shulaveri farmers and the local Mesolithic foragers.[8] Attempting to fill a gap in the chrono-cultural sequence, Kiguradze and Menabde proposed a transitional stage based on the aceramic/Early Neolithic sites or the Proto-Neolithic sites reported in western (e.g., Anaseuli I, Paluri, Nagutni, Darkveti) and southeastern (e.g., Dmanisi and sites near Lake Paravani) Georgia.[9] But these sites were attributed to the Neolithic based solely on techno-typological characteristics of chipped stones. An exception is Darkveti layer IV, where some cultigens and domesticated animals were reportedly discovered, though the details are not yet confirmed.[10] Lithic assemblages from these sites were differentiated from the Mesolithic by the scarcity of microlithic components and from the Shomutepe-Shulaveri by the lack of "an advanced blade technique."[11] In addition, Kiguradze and Menabde considered a specific tool type—hooked tools—which is characterized by squamous, subparallel blunting retouch on both lateral sides. They suggested that this tool type is similar in morphology and retouching technique to those from some Pre-Pottery Neolithic sites in southeast Anatolia (e.g., Çayönü) and northern Iraq (e.g., Tell Magzalia, Tell Shimshara) and thus proposed a cultural and chronological link.

The identification of the aceramic/Early Neolithic or Proto-Neolithic has profound implications for understanding the Neolithization processes in the South Caucasus. If this phase in fact exists and represents the "transition" between the Mesolithic and Shomutepe-Shulaveri, it indicates that indigenous foraging groups played a significant role in the formation of local farming societies. However, they may have received allochthonous cultural influences from the Middle East, as implied by the hooked tools. This important issue has recently led some researchers to reinvestigate the aceramic/Early Neolithic sites in western (e.g., Anaseuli I, Paluri) and southern (Paravani) Georgia.[12] These reinvestigations did not recover well-preserved assemblages of artifacts/ecofacts or radiocarbon dates that would verify the "aceramic Neolithic" attribution, but they confirmed that the sites mostly consist of thin cultural deposits that are often disturbed.

Similarly, the same issue also promoted excavations of new sites in the search for Neolithic deposits dated earlier than the Shomutepe-Shulaveri phase. Such sites include Kotias Klde Cave in western Georgia and the Kmlo-2 Rock Shelter in western Armenia. Kotias Klde contains stratified deposits including the Neolithic layer (A2) overlying the Mesolithic one (B).[13] Meshveliani et al.'s brief report on the Neolithic layer mentions some characteristics of chipped stones, including transverse arrowheads/trapezes, ventrally retouched denticulates, and flake scrapers. Because such a tool composition is reportedly similar to assemblages from the Darkveti Rock Shelter and Paluri (aceramic/Early Neolithic sites), radiocarbon dating as well as cultural/subsistence remains from layer A2 should provide significant data for verifying the aceramic/Early Neolithic phase in the South Caucasus.

In this respect, more detailed information is available from the Kmlo-2 Rock Shelter.[14] As for the lithics,

[3] Bellwood 2005; Zohary et al. 2012.
[4] Kiguradze 1986; Narimanov 1987.
[5] The terminology in this article follows Narimanov 1987, 192.
[6] Abibullayev 1959; Munchaev 1982.
[7] Munchaev 1982; Narimanov 1987.
[8] Kozlowski 1996.
[9] Kiguradze and Menabde 2004, 362.
[10] Nebieridze 1978 (cited in Korobkova 1996); Kiguradze and Menabde 2004.
[11] Kiguradze and Menabde 2004, 360.
[12] Meshveliani 2013; Arimura 2014.
[13] Meshveliani et al. 2007.
[14] Arimura et al. 2009, 2010.

the tool composition at Kmlo-2 is characterized by a high proportion (30%) of microliths dominated by backed bladelets and scalene bladelets with some geometric forms. It also includes "Kmlo tools," a tool type defined by continuous, parallel retouch by pressure flaking on lateral sides. Because this type is reminiscent of the hooked tools mentioned above, it was analyzed in detail for raw material sources, technotypology, and use wear. Although reported results suggest differences in the details of such technological behaviors between the hooked tools/Kmlo tools and the Çayönü tools, the two are at least partly contemporary. According to radiocarbon dates from Kmlo-2, Kmlo tools occur frequently in deposits dated to the end of the ninth into the eighth millennium cal B.C.E., as in the Middle East, but they also appear in upper layers dated to the fifth millennium cal B.C.E., in association with Chalcolithic sherds. Furthermore, the faunal and botanical remains from Kmlo-2 include no domesticated species.

Kmlo-2 has been designated equivocally as "Mesolithic/Early Neolithic" in the report.[15] However, these recent findings on the chronology, material culture, and subsistence practices of the site (e.g., high proportion of microliths; absence of groundstones, architecture, or figurative objects; exploitation of only wild plants and animals) collectively indicate its greater similarity to the Mesolithic than to the aceramic/Early Neolithic, at least in the sense used in the Neolithization scenario for the Middle East.[16] Moreover, even if one might regard Kmlo culture as Early Neolithic, the radiocarbon dates mentioned above indicate that this culture coexisted with the Shomutepe-Shulaveri culture during the sixth millennium cal B.C.E., representing a significantly different cultural group. The Kmlo culture was probably a localized culture developed by Early to Middle Holocene foragers in the Armenian highlands. Yet, such local aceramic communities may have maintained contacts with the Neolithic communities in the Middle East in a period before the fully Neolithic Shomutepe-Shulaveri culture appeared. The possibility exists that parts of communities such as the Kmlo-2 culture contributed to the formation of the latter even though others maintained a foraging subsistence strategy.

Under these circumstances, the beginning of the Shomutepe-Shulaveri culture has served as a kind of terminus ante quem for the initial development of farming communities in the South Caucasus, for which new important records have become available from recent excavations, including the excavations at Göytepe and Hacı Elamxanlı Tepe reported here. These new records are part of the results of archaeological investigations along the Kura and Araxes Valleys, which have greatly increased since the 1990s (fig. 1). First, the introduction of well-equipped research campaigns by the Armenian-French archaeological mission revealed that the earliest farming society, represented by Pottery Neolithic assemblages, reached to at least the southern foothills of the Lesser Caucasus Mountains at the onset of the sixth millennium B.C.E.[17] Subsequently, comparable research projects followed in the Kura Valley of southeastern Georgia[18] and West Azerbaijan[19] and the Mil Plain in southern Azerbaijan.[20] Recent investigations in the Middle Kura Valley are of particular interest because the region represents the heartland of the Shomutepe-Shulaveri culture.[21]

In this article, we present the most recent results obtained by the Azerbaijani-Japanese archaeological mission in the Middle Kura Valley with a particular focus on the chronology of the earliest Pottery Neolithic assemblages. We present a set of 46 radiocarbon dates from the two newly excavated Neolithic sites of Göytepe and Hacı Elamxanlı Tepe following a summary of current knowledge on the Shomutepe-Shulaveri culture and our investigations at these two sites. Combining the stratigraphies of these two sites provides a long sequence covering the earliest Pottery Neolithic phases. Radiocarbon dates from both sequences help establish a chronological framework for tracing Neolithic cultural developments in the northern foothills of the Lesser Caucasus. Last, we discuss how these results will help us develop future investigations of the aceramic/Early Neolithic stage and will promote our understanding of Neolithization processes in the South Caucasus.

THE SHOMUTEPE-SHULAVERI CULTURE OF THE POTTERY NEOLITHIC

The Shomutepe-Shulaveri culture was defined after two eponymous sites excavated in the 1960s: Shomutepe in Azerbaijan and Shulaveris Gora in Georgia.[22] Settlements assigned to this culture are densely distributed in the Middle Kura Valley, which is located mainly in Azerbaijan and southeastern Georgia (see fig. 1). The architecture of those settlements is characterized by circular buildings ranging from 2 to 4 m in diameter. The

[15] Arimura et al. 2010.

[16] Goring-Morris and Belfer-Cohen 2008.

[17] Badalyan et al. 2007, 2010; Hovsepyan and Willcox 2008; Arimura et al. 2010; Chataigner et al. 2012.

[18] Hansen et al. 2006, 2007; Hansen and Mirtskhulava 2012.

[19] Lyonnet and Guliyev 2010; Museibli 2011; Guliyev and Nishiaki 2012.

[20] Helwing and Aliyev 2012.

[21] Kiguradze 1986; Narimanov 1987.

[22] Kiguradze 1986; Narimanov 1987.

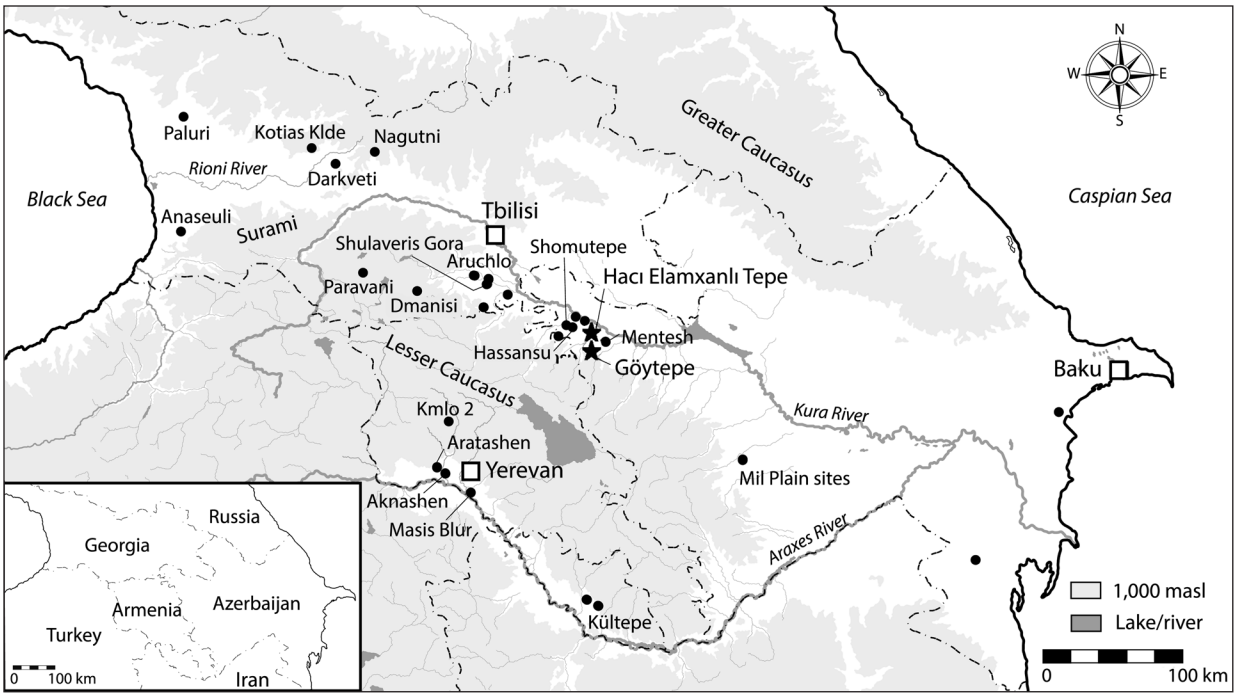

FIG. 1. Neolithic sites of the South Caucasus mentioned in the text. Stars mark Göytepe and Hacı Elamxanlı Tepe; dots indicate related sites; squares indicate capital cities.

buildings are connected by a curvilinear mudbrick wall, forming a circular compound enclosing a courtyard.[23] Hearths, bins, and other domestic features were found in the courtyard, which probably served as a daily activity space. A typical settlement, a relatively small mound no more than 2 ha, is composed of a series of such domestic compounds. The material assemblages include all the items considered classic for the Neolithic: pottery; flaked, ground, and polished stone artifacts; bone tools; and domesticated plant and animal remains. Plain ware is the predominant pottery type, but also present are a small number of decorated vessels with applied relief and incisions. Mineral-tempered ware is reportedly more common in the earlier phase of this culture, and plant-tempered wares are more common in the later phase.[24] With regard to the lithic industry, the most characteristic tools are pressure-flaked blades made of obsidian that was procured mainly from sources in the Lesser Caucasus. Developments in the bone-tool industry are also diagnostic of this cultural entity, as attested by a large variety of tool forms such as awls, hoes, hammers, spatulas, and picks.

While the Shomutepe-Shulaveri culture was defined based on archaeological records from the Middle Kura Valley, the distribution of comparable cultural assemblages is now known across a wider area. Instead of extending into the Lower Kura Valley,[25] they occur in the Araxes Valley south of the Lesser Caucasus (see fig. 1). The site of Kültepe-Nakhichevan, excavated as early as 1951, already yielded similar architecture and materials. Notably, the pottery assemblage included imported Halafian painted vessels. This evidence pointed to direct relationships with regions farther south,[26] which had never been known in the Kura Valley. Recent research upstream in the Araxes Valley on the Ararat Plain has recovered more examples of assemblages reminiscent of the Shomutepe-Shulaveri culture at Aratashen, Aknashen,[27] and Masis Blur.[28] Moreover, this work confirmed the occurrence of pottery imported from Upper Mesopotamia, including Hassuna and Samarra types found in the Araxes Valley.[29]

The Shomutepe-Shulaveri culture was once dated to the fifth and fourth millennia B.C.E.[30] However, since more reliable calibrated dates became available in the 2000s, the culture has been thought to date instead to

[23] Munchaev 1982.
[24] Kiguradze 1986; Chataigner 1995.
[25] Helwing and Aliyev 2012.
[26] Abibullayev 1959.
[27] Badalyan et al. 2007, 2010.
[28] Martirosyan-Olshansky et al. 2013.
[29] Badalyan et al. 2010.
[30] Kiguradze 1986; Narimanov 1987.

the sixth millennium B.C.E. Opinion on whether this culture persisted into the fifth millennium B.C.E. varies among authors.[31] Acknowledging the early stage of this research, we clearly need to develop a higher-resolution chronological framework of Shomutepe-Shulaveri cultural developments, which should help us obtain insights into the derivation of this cultural entity. Discussions about their possible correlation to other events including climatic changes[32] and interaction with societies in the Middle East also require a chronological comparison based on secure absolute dates. The two deeply stratified sites in the Middle Kura Valley, Göytepe and Hacı Elamxanlı Tepe, provide the stratigraphic sequences for such investigations.

THE NEOLITHIC SITES OF GÖYTEPE AND HACI ELAMXANLI TEPE

Göytepe and Hacı Elamxanlı Tepe are situated approximately 40 km east of Shomutepe, West Azerbaijan (see fig. 1). Göytepe represents one of the largest mounds known in the Middle Kura Valley, measuring approximately 145 m in diameter and 8 m in height (fig. 2). This mound was identified as a Neolithic site during a survey in the 1960s[33] and was confirmed through a stratigraphic section exposed by an Azerbaijani-French mission in 2006. From 2008 onward, it has been subjected to more extensive investigations by the Azerbaijani-Japanese mission.[34] A large exposure consisting of 10 excavation squares measuring 10 × 10 m each has been made on top of the mound's northern slope. The single square 4B at the northeastern edge was excavated down to virgin soil. These operations revealed 11 m of Neolithic deposits consisting of 14 architectural levels, all of which are assignable to the Shomutepe-Shulaveri culture without any breaks in occupation (see fig. 2).

This impressive sequence is unparalleled at any other regional Neolithic site and provides us with the first opportunity to examine chronological developments of the Shomutepe-Shulaveri culture at a single locality over a long period of time. Our preliminary analyses already hinted at a great deal of diachronic variability present in the artifact assemblages. The best example is seen in the pottery industry (fig. 3a–e).[35] Pottery was rare in the lowest levels but rapidly increased from the middle part of the sequence onward. The earlier pottery assemblages are also characterized by the almost exclusive use of mineral-tempered pottery (see fig. 3a, c, e), while the later ones showed more prevalent use of plant-tempered pottery (see fig. 3b, d). Decorative motifs on vessels also increased in the later levels. The previous techno-stylistic studies of pottery identified five developmental phases for the Shomutepe-Shulaveri pottery industry.[36] The stratified assemblages with secure radiocarbon dates from Göytepe are an invaluable source of information for reevaluating this five-stage periodization.

Along with Shomutepe, Aruchlo, Mentesh, Hassansu, and others (see fig. 1), Göytepe represents one of the oldest agricultural villages thus far known in the region. In an effort to look for earlier sites potentially related to the origin of these settlements, the Azerbaijani-Japanese mission started a regional survey in 2011, which resulted in the discovery of Hacı Elamxanlı Tepe. Situated only 1.5 km northwest of Göytepe (see fig. 1), this small mound is 60 × 80 m in diameter with a height of 1.5 m above the ground surface. The abundance of chipped-stone artifacts with Neolithic characteristics and the extremely rare occurrence of sherds in the surface samples suggested a possibly earlier date for Hacı Elamxanlı Tepe. Three seasons of excavations were carried out between 2012 and 2014 to test this hypothesis.[37]

At Hacı Elamxanlı Tepe, four 5 × 5 m squares were excavated to virgin soil at a depth of 1.5 m (fig. 4). Four architectural levels have been defined. The architectural remains consist of circular mudbrick buildings similar to Göytepe, but their configuration differs in that one small circular structure (ca. 3 m in diameter) abuts a larger one (ca. 5 m in diameter), making a snowman-shaped floor plan.[38] This distinct architectural plan, recovered in all levels of Hacı Elamxanlı Tepe, has never been attested at Göytepe. However, the architecture thus far defined at Göytepe is based only on data from the upper levels (levels 1–5), because current excavations of the lower levels are limited to an area too small to determine the complete architectural layout (see fig. 2). Accordingly, future excavations of the lower levels of Göytepe might produce comparable architectural remains. In fact, this is quite likely considering that comparable "snowman-shaped" building complexes have been reported at Aruchlo, where occupations contemporaneous with the lower levels of Göytepe have been exposed.[39]

Our excavations confirmed the rarity of pottery at Hacı Elamxanlı Tepe; only two dozen pieces were recovered

[31] Connor and Sagona 2007; Lyonnet 2007; Hamon 2008.
[32] Connor and Sagona 2007.
[33] Narimanov 1987.
[34] Guliyev et al. 2011; Guliyev and Nishiaki 2012; Kadowaki et al. 2015.
[35] Arimatsu 2014.
[36] Kiguradze 1986; Chatigner 1995.
[37] Nishiaki et al. (forthcoming).
[38] The plan could also be referred to as "8-shaped." However, one of the circular structures is always smaller than the other, differing from the 8 shape.
[39] Hansen and Mirtskhulava 2012, 61–2.

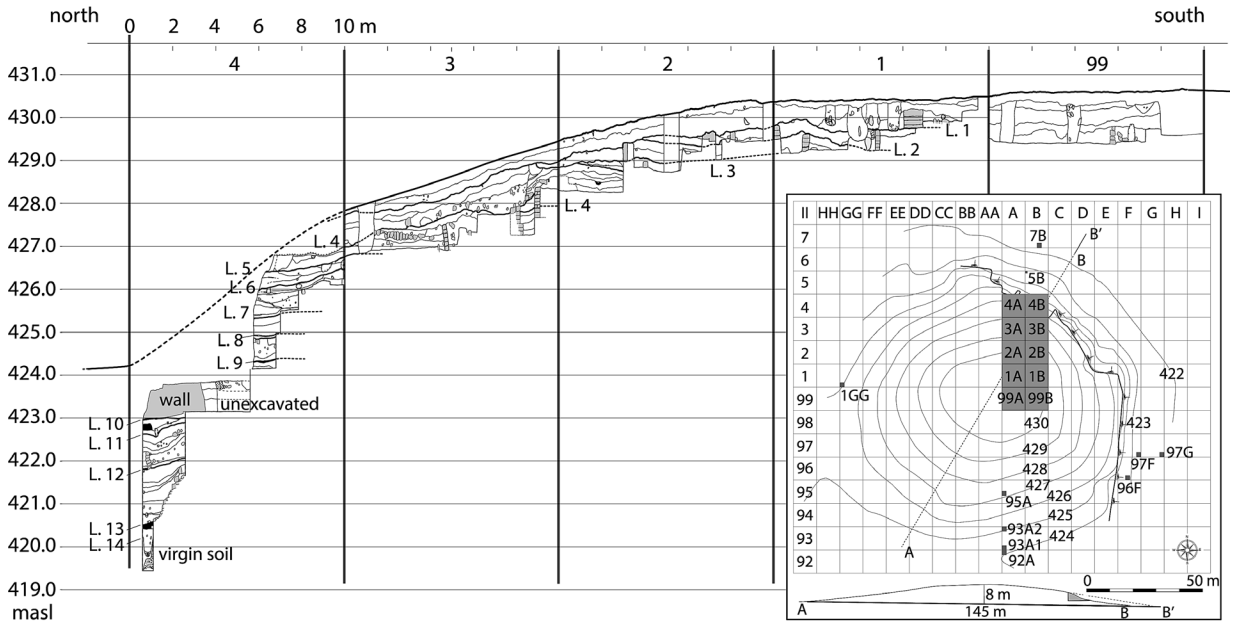

FIG. 2. The plan and stratigraphy of Göytepe. The stratigraphy shows the east wall of squares 4B–99B. The vertical scale is twice the size of the horizontal scale (L = level).

from four occupation levels. The majority is plain mineral-tempered pottery resembling wares in the lowest levels of Göytepe. However, it is significant that the pottery assemblage included two pieces of fine painted ware reminiscent of Upper Mesopotamian traditions, such as Samarra and Early Halaf, whose paste and decoration patterns strongly suggest their origin in other remote regions (see fig. 3f, g). Comparable painted pottery was never found in the much larger pottery assemblages from Göytepe or any other sites in the Middle Kura. Instead, as mentioned earlier, parallels are known only from the Araxes Valley.[40] The discovery at Hacı Elamxanlı Tepe therefore represents the first example of this pottery type from the north, suggesting that contact with contemporaneous societies in Upper Mesopotamia extended to the northern side of the Lesser Caucasus. Likewise, the lithic industry also shows similarities and dissimilarities to Göytepe. It contains numerous trapezes and steep round scrapers, both of which are represented much less frequently at Göytepe.[41] These observations suggest that the cultural phase discovered at Hacı Elamxanlı Tepe quite likely precedes the Shomutepe-Shulaveri phase at Göytepe, although the clear presence of domesticated plant and animal remains shows that it had a farming economy.[42]

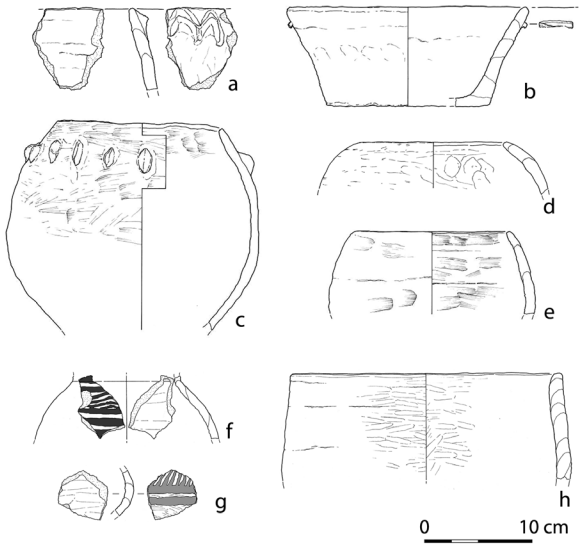

FIG. 3. Pottery from Göytepe (*a–e*) and Hacı Elamxanlı Tepe (*f–h*). Parts *a* (level 5), *c*, and *e* (level 11) are mineral-tempered ware; parts *b* (level 5) and *d* (level 6) are plant-tempered ware; parts *f* (level 3) and *g* (level 2) are painted fine ware; part *h* (level 3) is plant-tempered ware.

EXAMINATION OF RADIOCARBON DATES FROM GÖYTEPE AND HACI ELAMXANLI TEPE

Radiocarbon dates from these two sites are listed in tables 1 and 2. All dates except those from the 2012 season at Hacı Elamxanlı Tepe (see table 2, nos. 35–41, 44, 45) are previously unpublished. This data set comprises

[40] Badalyan et al. 2010.
[41] Nishiaki et al. (forthcoming).
[42] Nishiaki et al. (forthcoming).

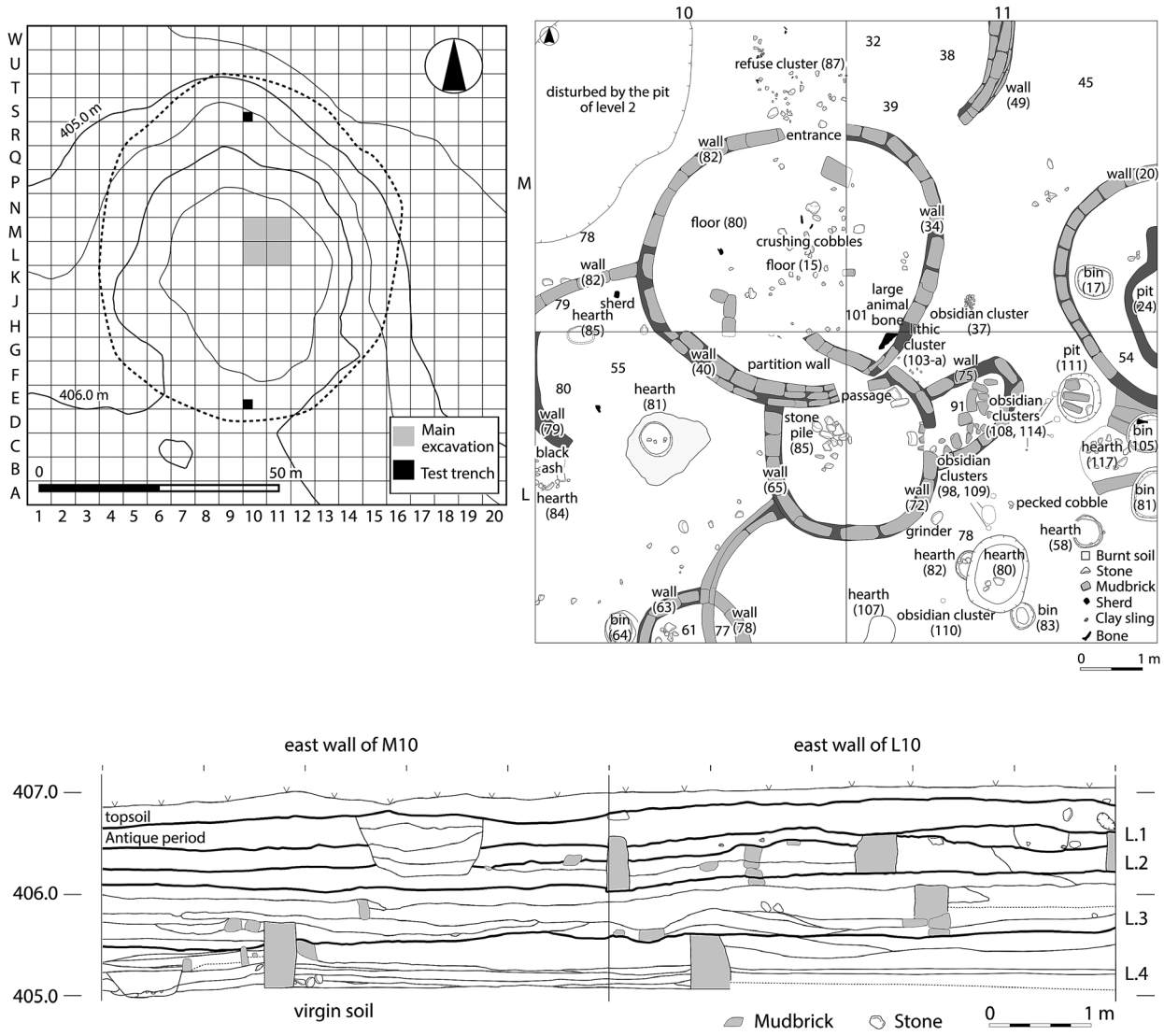

FIG. 4. The plan and stratigraphy of Hacı Elamxanlı Tepe. The top right shows the plan of a snowman-shaped architecture from level 3. The numbers in parentheses in the top right plan indicate loci defined during the excavations.

the largest collection of radiocarbon dates from a systematic sampling at stratified sites of this time period in the South Caucasus. They include three dates from Göytepe (see table 1, nos. 18, 19, 21) collected by the Azerbaijani-French mission in 2006 from their section exposure in an area now defined as squares 4A and 4B. We can assign the provenances of these older samples to our occupation levels.

All dates from both sites are based on charcoal remains. Although measured at different laboratories, they are more or less consistent with their stratigraphic positions. To evaluate the chronological range of each level, we conducted a Bayesian analysis to compare dates from different levels using the sequence and phase models of the OxCal calibration program (version 4.2.4) and the atmospheric curve of IntCal 13 (online appx., fig. 1, table 1 on AJA Online).[43] Table 3 presents the results of the analysis, which in the first model uses all dates from Göytepe and Hacı Elamxanlı Tepe, and in the second model excludes the dates with agreement indices lower than 60 in the first model. Although the second model uses fewer dates (30 vs. 45 in the first model) and lacks dates for some occupational levels, the results of the two models show similar overall temporal ranges

[43] Bronk Ramsey 2009, 2013; Reimer et al. 2013. For the application of the Bayesian analysis to the Neolithic chronology, see Campbell 2007.

TABLE 1. Radiocarbon dates for the Neolithic layers of Göytepe.

No.	Sample	Level	Lab No.	^{14}C Age (BP)	Cal B.C.E. (2σ)
1	GOY14, 1B-6	1	IAAA-141125	6385 ± 30	5486–5400 (32.9), 5391–5313 (62.5)
2	GOY14, 1B-3	1	IAAA-141123	6480 ± 30	5486–5372
3	GOY14, 1B-4	2	IAAA-141124	6565 ± 30	5607–5595 (3.4), 5561–5477 (91.6)
4	GOY14, 1A-1	3	IAAA-141120	6565 ± 30	5607–5594 (4.5), 5562–5477 (90.9)
5	GOY14, 1A-2	3	IAAA-141121	6530 ± 30	5558–5467 (94.7), 5399–5392 (0.7)
6	GOY14, 1A-3	3	IAAA-141122	6650 ± 30	5631–5519
7	GOY09, 1AII (79.1 cm bd)	3-1	TKa-14998	6460 ± 50	5508–5502 (0.8)
8	GOY09, 2AI (286.9 cm bd)	4	TKa-15000	6480 ± 45	5526–5356
9	GOY09, 2AII (226.1 cm bd)	4	TKa-14999	6480 ± 50	5528–5338
10	GOY08, 2B (225 cm bd)	4	TKa-14623	6500 ± 35	5528–5374
11	GOY08 (175 cm bd)	4	TKa-14622	6575 ± 35	5615–5585 (6.2), 5570–5482 (79.2)
12	GOY11, 4AI (oven)	5	IAAA-120064	6470 ± 30	5483–5371
13	GOY11, 3AII (oven)	6	IAAA-120063	6610 ± 30	5618–5508 (90.3), 5503–5490 (5.1)
14	GOY09, 4BII-21	7	TKa-15170	6410 ± 70	5490–5286 (91.0), 5273–5226 (4.4)
15	GOY09, 4BII-21	7	TKa-15169	6520 ± 70	5617–5357
16	GOY09, 4BII-51	8	TKa-15173	6450 ± 70	5543–5301
17	GOY11, 4BI-63	8	IAAA-120065	6560 ± 30	5608–5593 (5.1), 5562–5477 (90.3)
18	AF06-no. 4	8	UBA-7615	6574 ± 41	5616–5584 (13.9), 5572–5476 (81.5)
19	AF06-no. 1	8	UBA-7614	6575 ± 39	5615–5584 (13.5), 5571–5476 (81.9)
20	GOY09, 4BIIX-5	9	TKa-15168	6400 ± 50	5476–5306
21	AF06-no. 8	9	UBA-7616	6602 ± 39	5617–5484
22	GOY11, 4BI-84	9	IAAA-120066	6620 ± 30	5619–5508 (91.1), 5502–5491 (4.3)
23	GOY09, 4BIIX-53	10	TKa-15174	6530 ± 80	5623–5343
24	GOY09, 4BIIX-50	10	TKa-15172	6570 ± 70	5632–5462 (87.6), 5447–5379 (7.8)
25	GOY09, 4BIIX-51	10	TKa-15175	6580 ± 80	5644–5374
26	GOY11, 4BI-111	10	IAAA-120067	6610 ± 30	5617–5490
27	GOY09, 4BIIX-45	10	TKa-15171	6610 ± 50	5623–5483
28	GOY11, 4BI-116	11	IAAA-120068	6680 ± 30	5568–5546
29	GOY12, 4BIIX-113a	12	IAAA-120685	6590 ± 30	5612–5590 (11.5), 5565–5482 (83.9)
30	GOY11, 4BIIX-109	12	IAAA-120684	6620 ± 30	5621–5511
31	GOY10, 4BIIX-92	12	IAAA-120058	6730 ± 30	5714–5616 (92.4), 5584–5571 (3.0)
32	GOY12, 4BIIX-124	13	IAAA-120686	6800 ± 30	5731–5642
33	GOY13, 4BIIX-129a	14	IAAA-132140	6700 ± 30	5662–5605 (63.6), 5596–5560 (31.8)
34	GOY13, 4BIIX-129b	14	IAAA-132141	6690 ± 30	5659–5604 (60.4), 5596–5560 (35.0)

bd = below datum

of occupations at both Göytepe and Hacı Elamxanlı Tepe.

Radiocarbon dates from other recently excavated sites are compiled in tables 4–6. We used these dates to estimate temporal ranges for occupations at the sites, using the sequence and phase models of the OxCal program according to the stratigraphic successions at the sites when such records are published (fig. 5).[44] In the next section of this article, we discuss several implications of these results regarding the cultural

[44] The time range for Masis Blur in fig. 5 is overrepresented because of the small sample size of radiocarbon dates.

TABLE 2. Radiocarbon dates for the Neolithic layers of Hacı Elamxanlı Tepe.

No.	Sample	Level	Lab No.	^{14}C Age (BP)	Cal B.C.E. (2σ)
35	HAJ13 M11-13	1	IAAA-132144	6890 ± 30	5837–5723
36	HAJ12 M10-54	1	IAAA-120693	7000 ± 30	5985–5834 (92.6), 5826–5810 (2.8)
37	HAJ12 M10-68	2	IAAA-120695	6930 ± 30	5882–5733
38	HAJ13 L11-22	2	IAAA-132145	7000 ± 30	5983–5939 (23.6), 5932–5807 (71.8)
39	HAJ13 L11-106	3a	IAAA-132146	6990 ± 30	5981–5944 (17.1), 5926–5792 (78.3)
40	HAJ12 M10-15	3a	IAAA-120696	7070 ± 30	6015–5893
41	HAJ12 M10-79	3a	IAAA-120697	7060 ± 30	6012–5886
42	HAJ14 L10-122	3b	IAAA-141126	7015 ± 30	5990–5837 (94.6), 5822–5815 (0.8)
43	HAJ14 L11-128	3b	IAAA-141127	7030 ± 30	5991–5843
44	HAJ12 M10-96H	4a	IAAA-120698	7080 ± 30	6015–5895
45	HAJ12 M10-96I	4a	IAAA-120699	6950 ± 40	5969–5955 (2.7), 5907–5739 (92.7)
46	HAJ14 M11-102	4b	IAAA-141127	7025 ± 30	5987–5846

TABLE 3. Suggested date range for the occupation levels at Göytepe and Hacı Elamxanlı Tepe.

Site	Level	No. of ^{14}C Dates[a]	Date Range (B.C.E.)[b] First Model[c]	Date Range (B.C.E.)[b] Second Model[d]
Göytepe	1	2 (1)	5469–5459	5479–5473
	2	1 (1)	5486–5479	5490–5485
	3	3 (2)	5494–5490	5498–5494
	4	4 (2)	5500–5497	5507–5502
	5	1 (0)	5506–5503	–
	6	1 (1)	5514–5510	5516–5511
	7	2 (1)	5520–5517	5524–5520
	8	4 (3)	5529–5524	5533–5528
	9	3 (2)	5541–5534	5544–5539
	10	5 (5)	5558–5548	5556–5550
	11	1 (1)	5583–5571	5570–5563
	12	3 (1)	5616–5595	5583–5576
	13	1 (0)	5637–5629	–
	14	2 (2)	5645–5640	5596–5590
Hacı Elamxanlı Tepe	1	2 (0)	5838–5813	–
	2	2 (1)	5879–5856	5907–5890
	3	5 (5)	5922–5903	5933–5921
	4	3 (2)	5957–5938	5959–5944

[a] Numbers in parentheses are those with agreement indices above 60 in the first model.
[b] Date ranges are given by the mean values for the start and end boundaries of each level.
[c] The first model uses all ^{14}C dates from Göytepe and Hacı Elamxanlı Tepe except for no. 7 in table 1.
[d] The second model excludes ^{14}C dates with agreement indices lower than 60 in the first model (see online appx., table 1 for the original data).

TABLE 4. Radiocarbon dates from the Neolithic settlements of Aratashen, Aknashen, and Masis Blur in Armenia.

No.	Site	Context	Lab No.	^{14}C Age (BP)	Cal B.C.E. (2σ)
1	Aratashen	level IIa	Ly-2269	6660 ± 60	5663–5481
2		level IIa	Ly-2268	6820 ± 55	5811–5627
3		level IIb	AA-64175	6948 ± 73	5988–5713
4		level IId	AA-64176	6821 ± 46	5791–5631
5		level IId	AA-64178	6866 ± 49	5848–5658
6		level IId	AA-64177	6913 ± 49	5905–5711
7	Aknashen	horizon III, trench A. UF6	LY-13664	6350 ± 70	5511–5040
8		horizon III, trench 3. UF6a	Poz-22746	6420 ± 40	5487–5299
9		horizon III, trench 6. UF6b	UGAMS 2820	6690 ± 50	5723–5486
10		horizon III, trench 4. UF6	Poz-22747	6790 ± 40	5796–5569
11		horizon III, trench 1. UF6	Poz-22745	6910 ± 40	5975–5671
12		horizon IV, trench 4. UF8b	UGAMS 5804	6600 ± 25	5621–5481
13		horizon IV, trench 6. UF7a	UGAMS 4082	6560 ± 30	5617–5471
14		horizon IV, trench 3. UF7b	UGAMS 4080	6590 ± 30	5620–5477
15		horizon IV, trench 3. UF7b	UGAMS 4079	6640 ± 30	5636–5486
16		horizon IV, trench A. UF8	UGAMS 2293	6550 ± 50	5629–5367
17		horizon IV, trench 4. UF7a, str. 8	UGAMS 5803	6800 ± 30	5756–5624
18		horizon IV, trench 3. UF7a, F.7	UGAMS 2821	6740 ± 50	5766– 5515
19		horizon IV, trench 5. UF7a	UGAMS 4081	6720 ± 30	5721–5555
20		horizon IV, trench A. UF7	AA-68559	6868 ± 40	5888–5641
21		horizon IV, trench 1. UF8	UGAMS 5802	6940 ± 30	5975–5725
22		horizon IV, trench 5. UF8a	UGAMS 5805	6970 ± 25	5981–5740
23		horizon V, trench A. UF10	UGAMS 2292	6900 ± 50	5980–5644
24		horizon V, trench A. UF10/F.5	AA-68560	6930 ± 44	5984–5676
25		horizon V, trench A. UF11	AA-68561	7035 ± 69	6085–5717
26		horizon V, trench A. UF12	LY-13665	6920 ± 55	5986–5661
27	Masis Blur	upper, MB-1 2012.L10/4.105.1034	UCIAMS-121528	6935 ± 25	5880–5740
28		lower, MB-2 2012.M9/1.212.2110	UCIAMS-121529	6995 ± 20	5925–5835
29		upper, MB-3 2012.M10/1.319.3085	UCIAMS-121530	6940 ± 25	5885–5745
30		MB-4 2012.M11/1.023.0259	UCIAMS-121531	6765 ± 25	5715–5630

Note: For nos. 1–6, see Badalyan et al. 2007. For nos. 7–26, see Badalyan et al. 2010. For nos. 27–30, see Martirosyan-Olshansky et al. 2013.

TABLE 5. Radiocarbon dates from the Neolithic settlement of Aruchlo in Georgia.

No.	Context	Lab No.	^{14}C Age (BP)	Cal B.C.E. (2σ)
31	AR06D013-146	Bln-5950	6369 ± 46	5472–5229
32	AR06C021-151	Bln-5949	6451 ± 40	5482–5341
33	AR07K044-191	Hd-28505	6591 ± 22	5611–5485
34	AR07M013-181	Hd-28506	6650 ± 28	5629–5530
35	AR11AA007-364	MAMS-14735	6784 ± 26	5722–5638
36	AR11AA008-370	MAMS-14737	6788 ± 27	5724–5639
37	AR11AA009-386	MAMS-14738	6800 ± 26	5728–5644
38	AR11AA005-369	MAMS-14736	6814 ± 27	5736–5645
39	AR11U045-359/360	MAMS-14734	6844 ± 26	5775–5665
40	AR05A108a	Bln-5854	6850 ± 35	5835–5661
41	AR10B066-298	Hd-12879	6919 ± 30	5877–5731

Note: For all the dates in this table, see Hansen and Mirtskhulava 2012.

TABLE 6. Radiocarbon dates from the Neolithic settlement of Hassansu in Azerbaijan.

No.	Context	Lab No.	^{14}C Age (BP)	Cal B.C.E. (2σ)
42	Mound I (construction, 1.3 m bd)	TKa-15356	6475 ± 45	5516–5341
43	Mound I (pit, 2.3 m bd)	TKa-15355	6730 ± 50	5724–5603
44	Period II (1.4 m bd)	TKa-15357	6785 ± 50	5758–5617

bd = below datum

Note: For all the dates in this table, see Museibli 2011.

developments among the earliest agricultural communities in the region.

RESULTS AND DISCUSSION: CULTURAL DEVELOPMENTS IN THE EARLIEST AGRICULTURAL COMMUNITIES IN THE SOUTH CAUCASUS

First, the cultural sequence at Göytepe is bracketed within a period across the early to middle sixth millennium, ca. 5650–5450 B.C.E.[45] The beginning date may have been slightly later than the oldest dates reported from other Shomutepe-Shulaveri settlements located in the same valley—namely, Aruchlo (see table 5, nos. 39–41), Hassansu (see table 6, nos. 42–4), and Mentesh.[46] Considering the small number of radiocarbon dates available from these sites, the large data set from Göytepe is an important addition and suggests that the Shomutepe-Shulaveri settlements in the Middle Kura started in the first half of the sixth millennium B.C.E. However, the end date of occupations at Göytepe, ca. 5450 B.C.E., is more or less comparable to that of other sites (see fig. 5),[47] all of which point to a similar period: the beginning of the second half of the sixth millennium B.C.E. Displacing the earlier view regarding the continuation of this culture to the fifth millennium B.C.E.,[48] this finding gives one possible date for interpreting the observed sudden abandonment of many Neolithic settlements in the region without evidence of occupations continuing into the Chalcolithic.[49]

Second, the dates demonstrate that the settlement of Hacı Elamxanlı Tepe predates the typical Shomutepe-Shulaveri settlement of Göytepe (see fig. 5; online

[45] The accumulation rate is thus one architectural level approximately every 15 years, slightly shorter than the rebuilding cycle of mudbrick architecture in the Neolithic and Chalcolithic periods in the Middle East (Nishiaki 2001). This finding should aid investigation of the settlement pattern of the Shomutepe-Shulaveri culture.

[46] The radiocarbon dates for Mentesh are currently available only in a calibrated form. The oldest date (SacA26232/Gif-12713) corresponds to the end of the first quarter of the seventh millennium B.C.E. (Lyonnet and Guliyev 2012, 88).

[47] Lyonnet and Guliyev 2012.

[48] Connor and Sagona 2007.

[49] Lyonnet 2007.

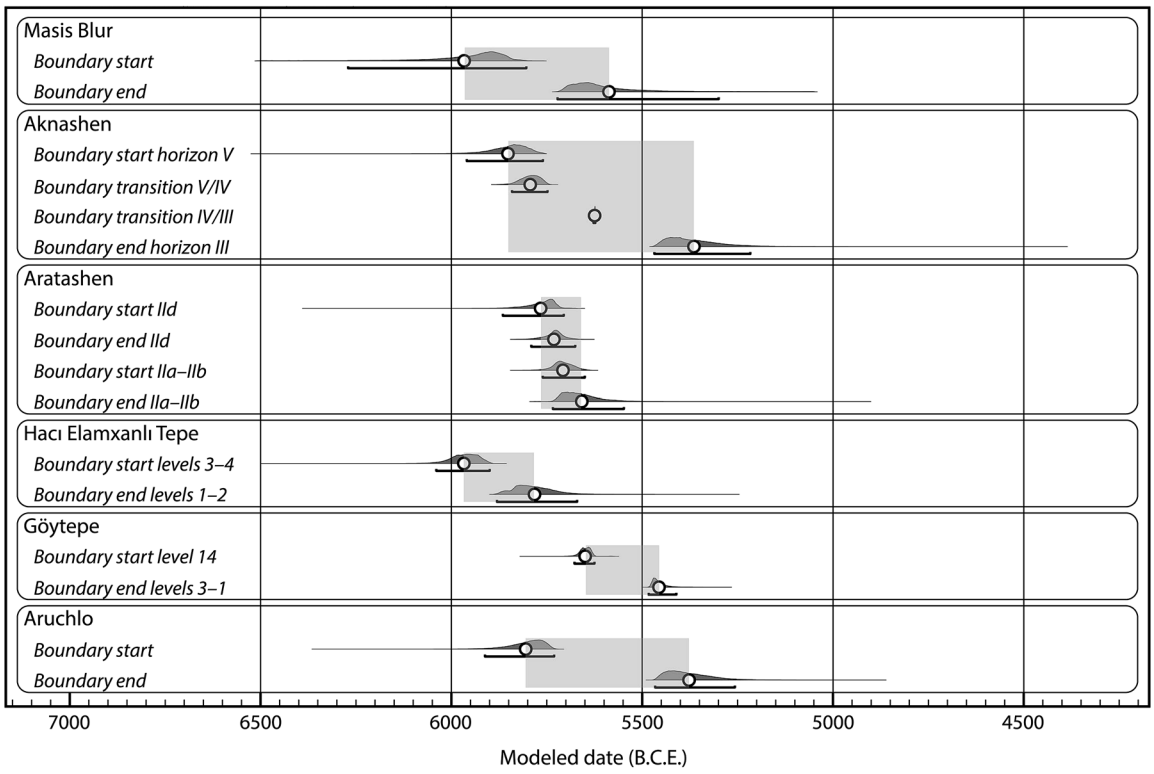

FIG. 5. Probability distributions of dates estimated with the sequence and phase models of OxCal 4.2.4 (Bronk Ramsey 2013), employing the IntCal13 atmospheric curve (Reimer et al. 2013), according to radiocarbon dates from recently excavated Neolithic sites in the South Caucasus. Gray areas mark the range between the mean values estimated for the start and end of the occupations at each site. As the number of dates decreases, the horizontal bars become longer.

appx., fig. 1). The Hacı Elamxanlı Tepe sequence covers the first quarter of the sixth millennium, ca. 5950–5800 B.C.E. No comparably early occupational traces have been identified at the other Shomutepe-Shulaveri settlements at Aruchlo, Hassansu, and Mentesh. However, the lowest phase of Aruchlo and Hassansu may have overlapped with the upper levels of Hacı Elamxanlı Tepe. While detailed comparisons can be made only after the full publication of these two sites, the occurrence of the peculiar snowman-shaped building complexes at Aruchlo[50] also suggests its chronological proximity. Looking outside the Kura Valley, the assemblages most comparable to those of Hacı Elamxanlı Tepe are found in the earlier stage of level II at Aratashen[51] and in horizons IV and V of Aknashen in the Araxes Valley.[52] The architecture, imported painted pottery, and other material remains from these sites closely resemble one another, although the available radiocarbon dates point to the slightly earlier chronological position of Hacı Elamxanlı Tepe.

The excavators of Aratashen and Aknashen associate the cultural assemblages of these and later horizons collectively with the Shomutepe-Shulaveri culture or its local variant. Considering that the almost identical entity occurs at Hacı Elamxanlı Tepe in a context predating the surrounding Shomutepe-Shulaveri settlements, the entity may well have developed into a typical Shomutepe-Shulaveri culture later in the Middle Kura. Meanwhile, the developments likely involved significant socioeconomic changes. We have already noted changes in the architectural plan, which most probably reflects transformations in social organization. In terms of material culture, an attempt was made to evaluate the diachronic pattern in the popularity of pottery, comparing the relative frequencies of sherds with lithic artifacts by architectural level at these two sites. As shown in figure 6, the very rare occurrence of sherds at Hacı Elamxanlı Tepe undoubtedly marks the beginning of pottery use in the Middle Kura. After a gap of a century and a half between the uppermost

[50] Hansen and Mirtskhulava 2012, 61–2.
[51] Badalyan et al. 2007.
[52] Badalyan et al. 2010.

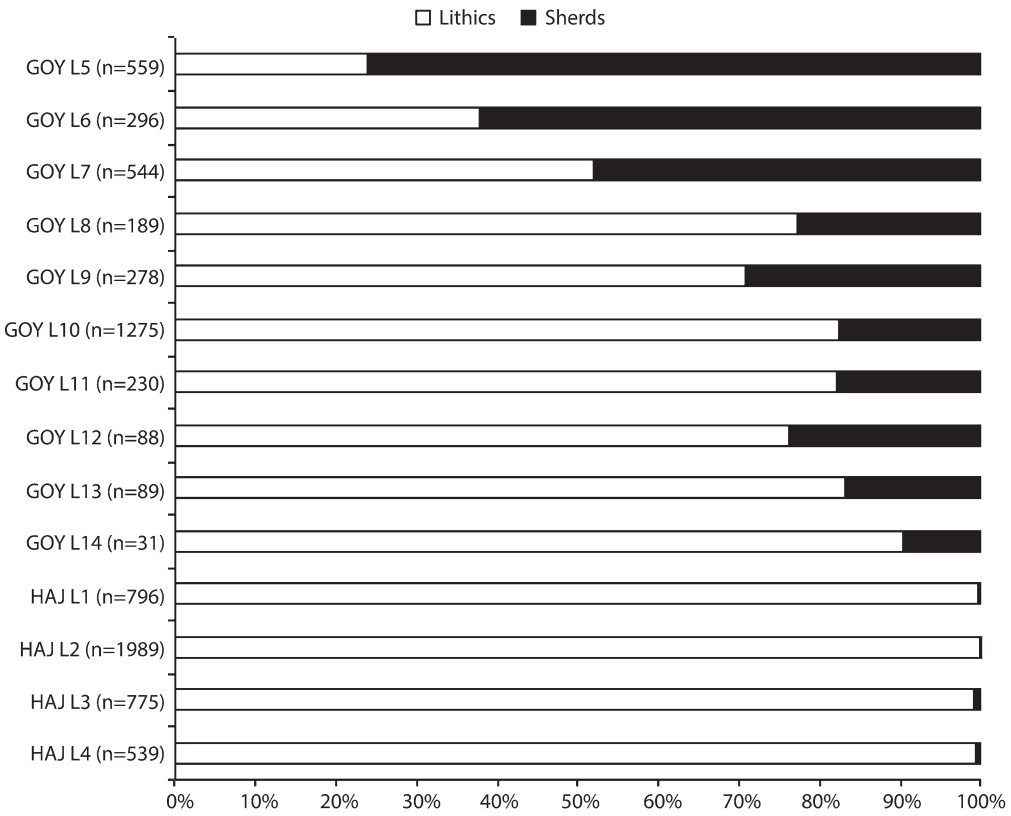

FIG. 6. The ratio of pottery sherds to lithic artifacts from Göytepe and Hacı Elamxanlı Tepe, by level.

level at Hacı Elamxanlı (HAJ L1) and the bottom level at Göytepe (GOY L14), the proportion of sherds increased slightly in the lowest levels of Göytepe. Subsequently, it started to increase significantly from the middle part of the sequence at Göytepe. The point marking the increase of pottery is placed after level 10. The pottery analysis shows that this was a period in which the proportions of mineral- and plant-tempered wares reversed—that is, the latter ware's abundance increased significantly. This change was then followed by remarkable technological and morphological diversification of plant-tempered wares (see fig. 3).[53] The overall trend shows that pottery came into prevalent use in the South Caucasus three to four centuries after its initial introduction. The socioeconomic roles of pottery also must have differed significantly between stages of the Early Pottery Neolithic. This issue, as well as changes in the architecture, forms the basis of an important research agenda for the future that aims to clarify cultural processes in the earliest agricultural communities in this region.

The third implication of our radiocarbon chronology concerns the similarity in cultural developments on both sides of the Lesser Caucasus in the Early Pottery Neolithic. The discovery of Hacı Elamxanlı Tepe pushes the onset of the Pottery Neolithic on the northern side back to the same period as the onset on the southern side, the beginning of the sixth millennium B.C.E. Considering that comparably early dates have also been obtained from the Mil Plain sites in the Lower Kura Valley,[54] the spread of Pottery Neolithic agricultural communities at this time seems to have been a common phenomenon across the South Caucasus. A straightforward interpretation of this phenomenon would relate it to the climatic amelioration after an episode of climatic deterioration known as the 8.2 ka event.[55] Many coincident cultural changes across the Middle East have been interpreted as having been triggered by this arid, cold period that lasted a few centuries and a subsequent, rapid recovery at the end of the seventh millennium B.C.E.,[56] which included

[53] Guliyev and Nishiaki 2012.

[54] Helwing and Aliyev 2012.

[55] Gronenborn 2009; Joannin et al. 2014.

[56] See, e.g., Nishiaki 2010; van der Plicht et al. 2011.

the dispersal of Neolithic economies and the reorganization of extant societies. The radiocarbon dates for Hacı Elamxanlı Tepe belong to the earliest stage of the climatic amelioration, suggesting that societies on the northern side of the Lesser Caucasus were also encompassed in the regional adaptive processes. More specifically, the known earliest phase at Hacı Elamxanlı Tepe is contemporaneous with the Proto-Halaf or the Transitional phase defined at Tell Sabi Abyad and Tell Halula[57] in Upper Mesopotamia. In this regional context, a distinct cultural trait of Hacı Elamxanlı Tepe is the near absence of pottery; however, some similarities to the Proto-Halaf culture are also detectable, including the appearance of painted fine ware and circular buildings of the snowman-shaped plan.[58] Closer examinations of this issue are ongoing and will be presented in another paper.

The similarities between the northern and southern foothills of the Lesser Caucasus go beyond the timing of the introduction of an agricultural socioeconomic structure. They can be seen in subsequent cultural developments as well, which appear to be unrelated to the climatic changes. The developmental stages noted at Hacı Elamxanlı Tepe and Göytepe were apparently shared by communities to the south, in the Araxes Valley. "A time of acceleration in the development of the site" has been pointed out in the Neolithic sequence of Aratashen, in the later stage of its level II.[59] Similarly, the Neolithic horizons at Aknashen have been grouped into two stages (horizons V–IV and III–II), between which significant developments in material and architectural remains are recognized.[60] Pottery production followed comparable diachronic developments. Pottery and diversifications of plant-tempered wares rapidly increased from levels IIc to IIb at Aratashen and horizons IV to III at Aknashen. All these changes occurred in the mid sixth millennium B.C.E. The close synchronicity of cultural developments in the Middle Kura and Araxes Valleys may well reflect substantial social interactions between these two regions. The identified cultural developments also strongly indicate that characteristics of the Shomutepe-Shulaveri culture were established gradually, as the result of local cultural evolution.

Now that the beginning of the Pottery Neolithic culture is clearly defined by abundant radiocarbon dates and cultural/subsistence records from Hacı Elamxanlı Tepe, Aknashen V–IV, and Aratashen IId–c, we have a new picture of the establishment of the Shomutepe-Shulaveri culture, one that contributes to discussions about the aceramic/Early Neolithic stage in the South Caucasus. The extremely rare use of pottery among these early farming communities suggests that they likely originated from the aceramic communities rather than the fully developed Pottery Neolithic ones migrating across the region. If future investigations provide more substantial records of the aceramic Neolithic phase, it would be worth examining whether this stage represents a transition from the local Early Holocene cultures such as those of Kmlo-2 or Kotias Klde layer A2, or whether it is dominated by allochthonous cultural/economic elements, possibly from the Middle East. This issue can be examined through multiple lines of evidence, including pottery and lithic assemblages, architecture, and domesticated plants and animals. Importantly, the regional comparison of these elements needs to be based on an accurate and precise chronological framework, which this study has aimed to develop.

CONCLUSION

Radiocarbon dates from Neolithic sites in Azerbaijan are still rare compared with the rapidly increasing data sets from sites in neighboring countries of the South Caucasus (see tables 4–6). The dates from Göytepe and Hacı Elamxanlı Tepe reported here are important additions to the corpus of new data from the Middle Kura Valley. It is hoped that the newly refined chronological framework provided by dates from Göytepe and Hacı Elamxanlı Tepe will serve as a reference point for identifying and interpreting cultural/socioeconomic developments in the earliest Neolithic societies in the South Caucasus.

The refined framework demonstrates the almost simultaneous spread of fully agricultural communities on both sides of the South Caucasus at the beginning of the sixth millennium B.C.E. The recovery of imported painted sherds at the earliest Pottery Neolithic sites suggests that the introduction of a farming socioeconomic structure was accomplished through close links with regions farther south in the Middle East. In addition, the new data from the sequential occupations from Hacı Elamxanlı Tepe to Göytepe provide chronologically and depositionally well-separated archaeological assemblages that have enabled us to clarify the timing and nature of cultural and socioeconomic developments in this period. Based on this refined chronological framework, and also given the extremely rare use of pottery at the beginning of this cultural stage, we propose that the cultural entity of the first agricultural societies in the region—that is, the Shomutepe-Shulaveri—did not appear "as a package" but was established in the process of local cultural evolution that most likely involved an aceramic stage.

[57] Campbell 2007; Molist et al. 2013.
[58] Akkermans and Schwartz 2003, 104–10; Molist et al. 2013.
[59] Badalyan et al. 2007, 60.
[60] Badalyan et al. 2010, 204.

Implications of this cultural development will be better interpreted when more archaeological data on the preceding aceramic communities become available.

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