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Wood resource management based on charcoals from the Bronze Age site of Gegharot (central Armenia)

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A B S T R A C T

Excavations conducted at the site of Gegharot in north central Armenia, along the northeastern margin of the Tsaghkahovit Plain (Aragatsotn region) have produced a large quantity of well-preserved charcoals. With occupations dating to the Early and Late Bronze Age, the site has been excavated since 2000 under the supervision of R. Badalyan and A.T. Smith under the auspices of the joint Armenian-American Project ArAGATS. The examination of the wood anatomy along three sections under a reflected light microscope, necessary for the identifications of charcoals, was systematically undertaken completed with the observation of the ligneous structure on transverse sections using a stereomicroscope. This dendrological approach provides valuable data for aiding identification of which part of the tree used, recording growth ring width, estimating wood diameter, and ascertaining the state of the wood before carbonization.

Different vegetational biotopes were identified from remains of the Early Bronze Age layers at the site: an open woodland with heliophilic shrubs (birch, maple, willow and *Pomoïdeae*), an open forest formation with notably oak with maple and ash trees and a wet zone with willows and ash trees. The estimated diameters of the wood used at that time did not exceed 12 cm. The wood collection from the Late Bronze Age levels indicates a pine and oak forest surrounded by open areas where birch trees and *Pomoïdeae* grew and wetlands with willow trees and elm as riparian forests. The onset of a colder and drier climate could be the cause of the disappearance of the ash trees, the appearance of oak pine forests and the reduced growth of the tree-ring width. The taxa list and the high frequency of the small diameters observed during both occupations can refer to a local woodland exploitation. According to the observation of the last ring before the bark, evidence from a single operation (T21), during the Late Bronze Age testifies to seasonal activities. Some large charcoals of pine or oak had exceptional long series of more than 60 tree-rings. The average curve built on the basis of the oak series has a length of 72 rings, the beginning of a tree-ring series building in Armenia for the Bronze Age.

1. Introduction

The Bronze Age in Armenia witnessed dramatic changes in the culture, economy, and society of human communities. Changes in the social landscape during this period are well-documented; on the other hand the environmental landscape itself is currently poorly understood. Anthracological studies from archaeological settlements are rare in the territory of Armenia. The analysis of Bronze Age charcoals from the site of Gegharot that we present here is the first systematic, large-scale application of this technique in Armenia. Two anthracological analyses were recorded in Neolithic settlements in the Ararat Plain. The first, focused on the site of Aratashen, was conducted by H. Pessin (Badalyan et al., 2007); the second, focused on the nearby settlement of Akhnashen-Khatunarkh, was conducted by R. Hovsepyan (Badalyan et al., 2010a). Pollen analyses including the Bronze Age period are sparse. Several studies have been conducted in the Sevan Lake area, including, on the eastern (Norashen; Sayadyan, 1978), south-eastern (valley of the Masrik river; Takhtajyan, 1941), western (valley of the Gavaraget river; Sayadyan, 1983) and, most recently

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southern shores (Vanevan, 1926 m a.s.l.; Leroyer et al., 2016). Another recent palynological study encompassing the Bronze Age was undertaken at the Zarishat marsh, situated on the Djavakheti Plateau at 2116 m a.s.l. (Joannin et al., 2014). The plant remains of the Early Bronze Age from Gegharot, Aparan-III, and Tsaghkasar-I, in the Mt. Aragats region, have been extensively studied (Hovsepyan, 2010).

Charcoals from archaeological settlements are linked to woodland exploitation mainly for fuel or timber needs. This woodland exploitation is related to environmental capacities. Thus, charcoals analyses can help to reconstruct nearby woodlands through comparisons between the current local woodland and the results of the anthracological analyses in order to interpret climate regimes and potential human impacts (Chabal, 1997; Willcox, 2002; Marston, 2009). In Armenia, understanding past woodland environments is important not only for an understanding of past economies but also in order to understand how vegetation has changed over time in relation to human activities, such as desertification caused by deforestation and over-grazing (Moreno-Sanchez and Sayadyan, 2005). The principal goals of this study will be to (1) reconstruct the different stages (over time) of the Bronze Age environment, (2) highlight the impact of climate on the environment in order to provide fundamental climate and environmental studies resources. It will thus be possible to approach (3) the interaction between the high-elevation vegetation resources and the human woodland exploitation.

2. Current vegetation and physical setting

Modern Armenia encompasses a land-locked, mountainous portion of the South Caucasus region. The regional climate today is arid and continental with considerable fluctuations in annual and sometimes daily temperatures. The complex relief of the region creates a vertical zonal climate. Annual precipitation fluctuates from 250 mm in arid regions, to 1000 mm in the highlands. Steppes and semi-desert formations are currently developed in several areas of the Armenian territory. In the northeast and the southeast part of Armenia, oak and beech mixed forests are well developed (Fig. 1).

The site of Gegharot (40°42.337′N; 44°13.516′W) is set on a rocky hillside (2155 m above sea level) of the Pambak range, on the northeastern edge of the Tsaghkahovit Plain (Aragatsotn Province). The geological substrate of the area consists of a Lower Cretaceous granite intrusion. It composes Gegharot's fortress hill. The western slope of Gegharot fortress is almost completely eroded (Smith et al., 2009). The soils of the study site are underlain by decarbonated mountain-chernozems with carbonates in deep slices (Hovsepyan, 2010).

The Tsaghkahovit Plain is currently under active cultivation by irrigation agriculture, while the slopes of Aragats are largely devoted to pasture (Smith et al., 2009). The study site is set in a mountainous environment totally devoid of trees (Fig. 2), except in a few small areas where afforestations of conifers were planted sometime after 1950. Local vegetation belongs to the bioclimatic domain of altitude steppes and subalpine meadows. The mean temperature in January is between −8 and −10 °C, in April 0 and 2 °C, in July 14 and 16 °C and in October 6 and 8 °C. Annual precipitation is about 650 mm (Badalyan and Avetisyan, 2007).

The ongoing excavations at Gegharot have been conducted under the auspices of the joint Armenian-American Project for the Archaeology and Geography of Ancient Transcaucasian Societies (Project ArAGATS). The Early Bronze Age (EBA) settlement at Gegharot consisted of a small village which appears to have been established on the citadel and upper terrace during the last centuries of the 4th millennium B.C. and then expanded during the early 3rd millennium to include residential and mortuary complexes on the lower western slope. During the Late Bronze Age occupation (LBA), a fortress hill covered an area of 3.43 ha (Smith et al., 2009) and consisted of a variety of built environments including work rooms, storage facilities and ritual shrines that appear to have practiced techniques of divination (Smith and Leon, 2014).

3. Material and methods

3.1. Samples locations from the Gegharot excavations

The excavations at Gegharot have produced a large quantity of well-preserved charcoals. Samples examined in this study came from operations T18 (excavated in 2006) and T21 (excavated in 2008). These operations were located on the western edge of the citadel (Fig. 3). Investigations in T18 (50 m^2) and the adjacent operation, T17, uncovered a two room complex constructed on bedrock which contained a large quantity of charcoal that likely resulted from an accidental fire event (Badalyan et al., 2008). The analyzed samples included in this study came from a domestic clay floor (T18 Δ13) and a domestic storage pit (T18 Δ32). The archaeological interpretation of the charcoals extracted from the floor suggests that they derived from structural timbers or roofing materials that collapsed during the fire. The sample T18 Δ32 is from the Early Bronze I period (defined by Elar-Aragats group ceramics) and has been dated by AMS radiocarbon dating to 3101–2907 cal. BC. The second sample T18 Δ13 has been related to the Early Bronze II phase (defined by Karnut-Shengavit group ceramics) dated by AMS radiocarbon determinations to between 2899 and 2668 cal yrs BC and 2861 and 2490 cal. BC (Badalyan et al., 2008).

Samples from T18 Δ16 and T21 were recovered from the Late Bronze Age (LBA) occupation of the site. T21 Δ6 has been radiocarbon dated to the Late Bronze Age (1370–1053 cal yrs BC) with ceramic evidence suggesting a primary occupation during the Late Bronze II phase (Badalyan et al., in press). Charcoals were found on the floor of the West Citadel shrine which was built atop bedrock (T21 Δ6) while two other samples came from storage pits set in the shrine floor (T21 Δ37 & 54). Like the EBA samples from T18 (T18 Δ13), the charcoals recovered from the LBA floor (T21 Δ6) are likely the result of roof collapse precipitated by a fire event. The last LBA sample, from T18 Δ16, is from a storage pit (Badalyan et al., 2008).

3.2. Methods

Charcoal identification was based on examination of wood anatomy across a transverse section and two longitudinal ones (radial and tangential) under a reflected light microscope (magnification 200 to 500×). The references used in identifying charcoals were Schweingruber (1990), Akkemik and Yaman (2012), and the collection of the Archeosciences Laboratory of the University of Rennes 1 (CReAAH). Most of the charcoal fragments could be identified at the genus level depending on the sameness of their anatomy. For paleovegetation reconstruction, a sufficient number of charcoals is required. Generally, occupation floors are good indicators, because they have a slow rate of deposition and arise from many possible origins (Chabal et al., 1999). Regardless of the state of preservation, the minimal number of identified charcoals depends on the saturation curve of taxa occurrence within one sample established during the charcoal study. The saturation point is obtained with the levelling off of the curve and seems to ascertain the taxa present in the sample (Chabal, 1997; OCarroll and Mitchell, 2012). The saturation points has been reached for the samples T18 Δ13 (no. charcoals = 150; Fig. 4), T18 Δ16 (no. charcoals = 186), T21 Δ6 (no. charcoals = 140) and T21 Δ37 (no. charcoals = 150).