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Carbonate features in the uppermost layers of Quaternary deposits, Northern Armenia, and their significance for paleoenvironmental reconstruction

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ABSTRACT

Recent archaeological studies in the Lori Depression of Armenia (Lesser Caucasus) revealed a series of multilevel Early Paleolithic (Acheulian) sites belonging to the Early-Middle Pleistocene stage of occupation of the Caucasus. In the uppermost layers of these sites, the paleosols and sediments contain carbonate features (CFs) whereas the lower layers are absolutely free from carbonates. The aim of this work is to examine the role of detected CFs as an indicator for reconstructions of the Early-Middle Pleistocene paleoenvironments, to determine the source, time and conditions of carbonates' accumulation in initially non-calcareous and high-degree weathered humid paleosols. Three sections were studied: Kurtan I, points 1–2 and Muradovo. There are different forms of CFs represented by the calcified root cells in the layer 1, the hard nodules in the layer 2 and the laminae-like carbonates in the layer 3 of the sites studied. All the CFs are of the aqueous (hydrogenic) origin. The CFs of the uppermost layers 1 and 2 in the Kurtan I, point 2 were accumulated in the Holocene lake. The calcified root cells were formed on the swamp shore whereas the hard nodules on the lake bottom under stagnant water. The laminae-like carbonates in the layer 3 were accumulated in the Kurtan I and Muradovo sections due to strong erosion cycle(s) in the Late Pleistocene interglacial period(s) that led to the limestone scour in the region by ground and surface water. They reflect the earliest stage of the allochthonous carbonate accumulation in the area dated by radiocarbon method to approximately 20 ka cal BP. Therefore, all the CFs cannot be regarded as indicative of Early and Middle Pleistocene environmental changes, as they appeared in the uppermost layers of the studied sections much later than the time of formation for the surrounding groundmass.

1. Introduction

Paleosols are important source of information for decoding history of the Quaternary environments, and have high potential for local paleoecological reconstructions in connection with archaeological research. Paleopedological data take on special significance concerning the earliest humans, because any information of conditions of their life is of particular importance. One of the most promising challenges for Pleistocene paleopedology is an analysis of environments of the initial hominid dispersal in Eurasia (Sheldon and Tabor, 2009; Beverly et al., 2014). According to archaeological data, the earliest humans developed and initially dispersed along the tectonic structures of the African-Arabian rift with favorable semi-open landscapes and deposits of rocks suitable for manufacturing lithic artifacts. One of the main routes of their migration from the African homeland to Eurasia led through the Near East to the Caucasus isthmus. Recent archaeological research in the Lori Depression of Armenia (Lesser Caucasus) revealed a

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series of multilevel Early Paleolithic (Acheulian) sites belonging to the Early-Middle Pleistocene stage of occupation (Aslanyan et al., 2007; Lyubin and Belyaeva, 2010, 2011; Presnyakov et al., 2012; Belyaeva and Lyubin, 2013). These sites are represented by stratified deposits having different palaeosol characteristics.

Pleistocene paleosols have been previously studied in Armenia but to a very limited extent, many years ago (Zakharov, 1929, 1946; Mirimanov, 1932; Sayadyan, 1968). The morphological description and some analytical characteristics are given for the Middle Pleistocene paleosols buried in the Shirak (Gyumriy or Leninakan) depression, which borders the Lori region on the east (Sayadyan, 1968, 2009). Those paleosols described in several sections are located between volcanic tuff and ancient lacustrine sediments dated to the Gyurgyak horizon of the lower Khazar stage (0.2–0.3 Ma) according to the local stratigraphic scheme. The paleosols have been classified as Chernozemic-type soils with comparatively short-term period of development and rapid burial under volcanic material. They had a complete set of horizons but small thickness and contained insignificant quantities of carbonates.

In our recent publications on the paleosols and sediments in localities of lithic tools of hominids in Northern Armenia, there is information about the calcareousness of the uppermost layers situated not deeper than 3.5–4 m from the surface, and the deeper located layers of the studied sites are absolutely free from carbonates (Sedov et al., 2011; Khokhlova, 2013). There are no complete-profile soils in our exposures, and we deal with individual horizons or even pedo-litho-sediments. The lithic tools of the ancient hominids within the uppermost layers may have calcareous coatings. The study of layers with carbonate features (CFs) showed that the accumulation of carbonates is a superimposed process which obliterates and/or camouflages the signs of antecedent humid pedogenesis. This stage is displayed in the strongly weathered primary minerals, clay translocation, fersialitization, and gleying of the material between CFs.

Some questions remained unsolved. They are connected with role of detected CFs as an indicator for reconstruction of environments in which ancient hominids lived. The source of carbonate material in formerly non-calcareous and strongly weathered and mainly acid sediments of the region is unclear. The period and conditions of carbonate accumulation in the uppermost layers of the Quaternary sediments in northern Armenia are not known. To try to answer those questions, this study was conducted.

2. Materials and methods

2.1. Location of study sites and bioclimatic conditions

The buried horizons of the Pleistocene paleosols were discovered in northern Armenia (Lori depression) in the course of archaeological studies conducted by the Armenian-Russian expedition headed by S.A. Aslanyan. Since 2003, more than 20 Acheulian localities including 4 stratified sites (Dashnadem 3, Muradovo, Kurtan I and Karakhach) were found in this area (Aslanyan et al., 2007). The Dachtadem 3 deposits yielded the Late Acheulian industry assigned to the second half of Middle Pleistocene, whereas the sediment sections of Muradovo, Kurtan I, and Karakhach excavated by V.P. Lyubin and E.V. Belyaeva, Saint-Petersburg Institute of material culture history of RAS, contained older Early and Middle Acheulian industries. The overwhelming majority of layers in the excavated sites is carbonate-free and includes different portions of volcanogenic materials of moderately alkaline and acidic composition (Trifonov et al., 2014). This paper is devoted to the examination of two sites, Kurtan I and Muradovo (Fig. 1), where in the uppermost layers of the sections the different CFs were described.

The Acheulian sites, Kurtan I and Muradovo, are located in the Lori intermountain depression surrounded by the Basum, Javakhet and Somkhet ridges of the Lesser Caucasus. The area lies within the modern mountainous steppe zone at about 1300 m a.s.l. (Fig. 1). The Lori Depression coincides with a fault (Gabrielyan, 1961) and represents a slightly undulating plain composed of lacustrine deposits with layers of rock debris transported from the adjacent uplands. The Basum and Somkhet ridges are formed by dislocated Jurassic and Cretaceous sedimentary rocks with volcanic bodies of Eocene age. The Jurassic and Cretaceous rocks contain marine limestone. The Javakhet ridge is of volcanic origin and formed in the Late Pliocene-Early Pleistocene. The heterogeneous lithology in the lower part of the studied sections reflects Early Pleistocene volcanic activity. The last known eruptions in the area were in the middle Calabrian (1.5–1.4 Ma). The late Calabrian and earliest Middle Pleistocene sedimentation (~1–0.5 Ma) occurred in stagnant water, partly in lacustrine conditions. This was expressed by formation of relatively fine-grained lacustrine sediments in the uppermost part of the studied sections (Trifonov et al., 2014).

The climate is continental: summer is moderately warm (mean July temperature +17°); winter is moderately cold (mean January temperature −4°). The snow cover in winter season is stable; mean annual precipitation is about 700 mm (Bagdasaryan and Gabrielyan, 1962).

The Kurtan I site (N40°58′04.14″; E44°31′34.46″,1300 a.s.l.) was found in the sand quarry situated about 1.5 west from Kurtan village on the NW slopes of the Surb-Sarkis sub-volcanic mount, on the right bank of the Gerger River (a tributary of the Dzoraget River), (Fig. 2A). The thickness of the Pleistocene deposits underlain by doleritic basalt in this quarry reaches 15 m. Three U–Pb dates of the zircons from volcanic ash lying below pumice sands under the Kurtan I sediment section were 1.432 ± 0.028 Ma, 1.495 ± 0.026 Ma and 1.496 ± 0.021 Ma (Presnyakov et al., 2012). According to those dates, paleomagnetic records and general geological correlations in the region (Trifonov et al., 2014), cultural layers 1–3 with the Acheulian lithic industry of this site date between the second half of the Early Pleistocene (1.8–0.781 Ma) and the beginning of the Middle Pleistocene (≥0.5 Ma).

We examined two sediment sections of the Kurtan I quarry. The first is in the south-west wall, where the excavation reached the depth of 7 m (Kurtan I, point 1 – KIp1). The excavation in the north-eastern wall was 4.5–5 m deep (Kurtan I, point 2 – KIp2). KIp1 represents a less eroded slope and contains a greater number of thick layers. At KIp2, the layers are thinner, and the boundaries between them are sharper due to erosion (Fig. 2A). Both the KIp1 and KIp2 sections have three layers containing different morphological forms of carbonates. The important reason to study the KIp1 wall is the fact that its lowermost layer 3 with CFs, which are very morphologically similar with those in layer 3 of the KIp2 wall, is much deeper than in KIp2, and is separated from overlying deposits by the noncalcareous layer 2a. Such a carbonate-free layer is absent on the KIp2 wall.

The Muradovo site (N41°05′08.50″; E44°09′33.99″, 1656 a.s.l.) is located 33.5 km northwest of the Kurtan I quarry and 1.6 km southwest of Blagodarnoe village (Fig. 1). The site was found in the Pleistocene deposits partly exposed by a small stream running from the Javakhetsky volcanic ridge (Fig. 2B). Only the uppermost layers 2 and 3 of the Muradovo site contain CFs. Layer 1 of Muradovo site is of Holocene age and contains redeposited pieces of typical local Late Acheulian lithic tools (flat bifaces, Levallois products), whereas layers 2 and 3, on the basis of geological correlation between different archaeological sites of the Lory depression, may be placed into the 1.0–0.8 Ma interval (Trifonov et al., 2014).

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