Abstract. The archaeological sites Gradishte 2 and Gradishte 3 are located along the Haemus Motorway. The area was inhabited for a long period of time – from the late Neolithic–Chalcolithic period, Early Iron Age up to late antiquity. All excavated structures such as pits, dwellings, and EIA necropolis were situated in a similar type of sediments – clayey loess. Differences between the loess in these sites are the clay content, freshness, and roundness of quartz and feldspars. They are explained by different watershed areas, variations in the source area, and weathering intensity.

Keywords: archaeology, sedimentology, clayey loess, Quaternary, Shumen District.

Introduction

In the present study, we examined the sediments hosting two archaeological sites: Gradishte 2 and Gradishte 3 along the Haemus Motorway. The excavations are located on the right or northern bank of the Pakosha River, 1.5 km northwest of the village of Gradishte, Shumen District, NE Bulgaria (Fig. 1a). The distance between both sites is about 600 m. They are located in the area enclosed between the Shumen Plato and Samuilovo Highs in the eastern part of the Danube Plain. The southern slopes of the Samuilovo Highs are sloping at about 4° to the Pakosha River at the site Gradishte 2 and at 2.5° at Gradishte 3. The highs are cut by short streams, tributaries to the Pakosha River, as well as dry valleys.

The study aims to characterize the palaeoenvironment and sedimentation during the habitation of this area in the Prehistoric and Ancient times.

Archaeological setting

The earliest traces of habitation in the multi-layered archaeological site Gradishte 2 date back up to the beginning of the Neolithic–Chalcolithic Age. There are numerous pits containing animal bones and ceramic vessels. The basement of a small square-shaped dwelling related to this period was also discovered. A large settlement arose here at the beginning of the 4th millennium BC. Initially, its territory was partially surrounded by a moat, which course partially coincides with the bed of an ancient stream. The ancient inhabitants lived in small, half-buried dwellings, oval in plan. Over time, the moat has lost its functions. The locals filled it with large quantities of broken pottery, ash, and animal bones, then built new dwellings on its old course. Unlike the previous ones, these are terrestrial, with walls built of intertwined branches between wooden trunks driven into the ground and plastered with clay. The settlement perished in a fire but was soon rebuilt. There is little data about the last phase of its life. A change in architecture is recognized as rectangular buildings with two or three rooms and length between 11 and 15 m appeared.

During the Late Bronze Age (15th–13th centuries BC), the life in this site was renewed, which is evi-
dened again by pits with economic and domestic purposes, a dwelling from the period.

In the second half of the Early Iron Age (VIII–VI centuries BC), the site of the ancient settlement already had other functions. From this period, 17 burials from a bi-ritual necropolis were discovered. Most burials were carried out by cremation but two inhumations were also discovered. The bones, cleaned of ash and coal, were placed in clay urns together with some parts of the clothing of the deceased – buttons, fibulae, etc. The urns were covered with clay panicles and placed in the burial facilities. The latter are of two types – ordinary circular plans or rectangular ones, the walls of which are built of broken stones without solder. The burials are of adults. The first was buried in a hawker position, and the second stretched out on his back with his head to the east. The necropolis was in use for a long time, as evidenced by the partial overlapping of some graves.

The last period of habitation was witnessed during the era of late antiquity (IV–VI century AD) when a large and rich settlement arose here. The dwellings are small, most half dug in. Numerous coins, ornaments, metal objects, etc., have been found from this period.

Excavations at the Gradishte 3 site were carried out in 2019 and covered an area of 0.02 km². The prehistoric features were represented by round cylindrical pits with diameters between 1.10 and 1.30 m and oval ones with sloping walls, which dimensions vary between 1.90 and 2.50 m. Twenty-one prehistoric pits with no defined arrangement were uncovered, as well as a necropolis from the Early Iron Age (EIA) (Petrova et al., 2020).

According to the ceramic material, only one of the prehistoric features dates to the Early Chalcolithic, containing sherds with graphite-painted ornament. The others belong to an earlier chronological level, which was defined as a period of transition from the Late Neolithic to the Early Chalcolithic (the end of the sixth and the beginning of the seventh millennium BC). They contain fragments of pottery, animal bones, and flint artifacts or only secondarily burnt pieces of daub of various sizes.

The EIA necropolis (7th–6th c. BC) is situated at the west edge of the archaeological site. Seven burial pits with diameters between 2.20–2.40 m were registered there. Five pits contain one urn each, with cremated human remains. A collective grave was also excavated, with a total of twelve ceramic vessels, including three urns. The cremated human bones were placed at the bottom of the vessels and mixed with burial gifts (bronze fibulae, iron knives, etc.). Burial gifts were also placed right next to, or, under the urns (Petrova et al., 2020).

**Geological setting**

Archaeological excavations are situated on the loess cover above the Lower Cretaceous deposits of the Razgrad Formation (Filipov, Decheva, 1995). The last is composed of clayey limestones and marls and built a vast territory in the eastern parts of the Danube Plain and Pre-Balkan (Philipov, Decheva, 1995). South of the Pakosha River, the Lower Cretaceous sediments of the Gorna Oryahovitsa Formation (Nedyalkova, Cheshitev, 1995) are cropping out. These are marls and clayey marls with sandstone intercalations. The hills south of the river are built up of various Upper Cretaceous limestones, marls and detrital sandstones referred to the following formations: Dobrin dol, Venchan, Shumen, Novachene, Nikopol, and Mezdra (Nedyalkova, Cheshitev, 1995). The Palaeogene marls, clayey sands, and nummulitic limestones are exposed on the top. Along the riverbed, the Holocene alluvial deposits are observed – sands, clays, and gravels.

The loess cover here is at about 3–5 m (Minkov, 1968) thick and it is represented by clayey loess (Minkov, 1968; Jipa, 2014). The stratigraphic sequence in the archaeological sites is consistent with the sedimentary succession as for the site Gradishte 2 from bottom to top is as follows: loess, beige with concretions up to 4×2 cm, over 10 cm thick; 30–35 cm thick transitional layer, grey-brownish; 20–40 cm thick “brown” layer, with coatings and patches of CaCO₃; 20–30 cm thick archaeological layer, with calcareous crusts and concretions up to 5–6 mm. For the Gradishte 3 site the sedimentary succession is: more then 20 cm compact silty clayish layer, calcareous, with carbonate concretions; 37 cm thick layer associated with the registered prehistoric archaeological features (gray calcareous clayey silt), 30 cm dark brown compact layer (plow zone), and an EIA necropolis is associated with the lower section of this stratum.

**Material and methods**

Both archaeological sites were sampled (9 samples) to clarify the composition of the deposits from stratigraphic horizons in the excavations. For the study of the sediments, grain-size and mineralogical analyses were applied. All samples were treated with 2% HCl to assess the carbonate component. The grain-size analysis includes sieve analysis, made with Frisch Analizette, using the φ-scale of Wentworth (1922), followed by pipette analyses for the fractions below 0.063 mm. Results were plotted on a ternary diagram (Folk, 1954). Mineralogical analysis was performed under a polarizing microscope on the 0.063–0.125 mm and 0.125–0.25 mm fractions, in immersion Eugenol with a refraction
coefficient of 1.541, on a minimum of 500 grains. Fractions over 0.25 mm were determined under a binocular microscope.

The watershed model and relief analysis were generated with the GIS software Global Mapper 11.

Results and discussion

Analysis of the carbonate content shows that in deposits from the site Gradishte 2, the carbonate content varies from 19.77% to 26.87% (Fig. 1b, 1), while at the site Gradishte 3 it is significantly higher – from 17.96% to 32.09% (Fig. 1b, 2). In both sites, silt fraction dominates, which determined these deposits as silt and clayey silt (mud) according to Folk (1954) (Fig. 1c). On the site Gradishte 2, silt fraction varies from 71.6% to 73.67%, followed by clay fraction from 5.56% to 8.37%, and the sand fraction is the least one – between 0.02% and 1.42%. On the ternary diagram (Fig. 1c), these samples are disposed very near to each other in a compacted group. On the other hand, in the sediments from the Gradishte 3 silt fractions range from 47.42% to 66.32%. The clay fraction is much higher between 14.86% and 28.51%, and the sand fraction from 0.57% to 2.67% is higher than in the site Gradishte 2.

The mineralogical composition of very fine and fine sand fractions is very similar. In samples from both sites Gradishte 2 and Gradishte 3, the main minerals are quartz, feldspar, plagioclase, and mica, accessory – amphibole, zircon, titane, and single grains of tourmaline, garnet, epidote, and apatite. In one fraction 0.063–0.125 mm in sample Gr3/2 few glauconite grains were observed. In the site Gradishte 2, quartz crystals are presented by fragments, cracked and polished, and subrounded. Feldspars are mainly potassium-sodium (alkaline) type, cracked, and significantly altered (clayey). Sodium-calcium (plagioclase) is in lower concentrations and also cracked and clayey. Micas are represented by biotite and minor muscovite. They are weathered and half-destroyed. Accessory minerals are also fragments, cracked and polished, with no preserved crystal forms. In the site Gradishte 3, quartz is also

Fig. 1. a, geological map (after Nedyalkova, Cheshitev, 1995; Philipov, Decheva. 1995) with the position of the two archaeological sites, legend: 1, alluvial deposits; 2, eolian-alluvial-talus deposits; 3, eolian deposits; 4, undivided Paleogene sediments; 5, Kalaka Formation; 6, Mezdra Formation, Nikopol Formation, Novacene Formation; 7, Shumen Formation; 8, Vencan Formation; 9, Dobrindol Formation; 10, Gorna Oryahovica Formation; 11, Razgrad Formation; 12, Hitrino Member; 13, Kaspichan Formation; 14, normal lithostratigraphic boundary, proved; 15, normal lithostratigraphic boundary, supposed; 16, unconformable (transgressive); 17, normal fault, supposed; b1, histograms of carbonate content of the site Gradishte 2; b2, histograms of carbonate content of the site Gradishte 3; c, ternary diagram (after Folk, 1954)
found as fragments, cracked and polished, but there are also fresh crystals that are subrounded to rounded. The feldspars from the site Gradishte 3 are in smaller quantities compared to those from the site Gradishte 2 but are significantly more preserved. Micas are the same content, weathered and destroyed, but again in smaller quantities. Accessory minerals have the same characteristics as in samples from the site Gradishte 2.

The mineral composition of fractions larger than 0.25 mm is similar, too. The main mineral is quartz, followed by small quantities of feldspars, single mica flakes, amphibole crystals, and iron hydroxides. Charcoals are registered in various amounts but are abundant in archaeological layers in both sites (samples Gr2/3 and Gr3/3). In the sample Gr3/3, few glauconitic grains were observed. Quartz grains are represented chiefly by monocrystals, and very rare by quartz aggregates. Clear transparent grains are more often in the samples from the site Gradishte 3. In the finer fractions, quartz grains are more rounded and transparent grains are more rounded than translucent.

According to the generated watershed model, the two sites are in different watersheds. They are separated from another little watershed zone in-between. This led to variation in a clay-silt-sand ratios of both sites. According to this ratio, eight of the samples are silt sediments and one sample is mud sediment (Gr3/3). This refers to the sediments from both archaeological sites to clayey loess as described by Tchakalova and Karastanev (2019). Their mineral composition is comparable with the composition of loess in North Bulgaria (Antonov, 2003).

The differences in the weathering stage of the minerals from the two sites may be due to the change in the way of sedimentation. The site Gradishte 3 is located at a lower elevation and this surface was subjected to more advanced weathering and the materials there were more altered. The mixing of fresh and more eroded minerals in the site Gradishte 3 is an indicator of two different source zones.

The presence of glauconite there is evidenced for probable transport from the south, where the Upper Cretaceous calcareous and clayey sandstones with glauconite crop out. Amphibole and micas could be transported from the same direction, too. Jipa (2014) supposes that amphiboles are transported from the south to the loesses in the Danubian Plane.

**Conclusion**

The southern parts of the Samuilovo Highs, north of the Pakosha River were inhabited for a long time period – from Late Neolithic–Chalcolithic period, Early Iron Age up to late antiquity. All excavated pits, dwellings, and EIA necropolis in the archaeological sites Gradishte 2 and Gradishte 3 were situated in a similar type of sediments – clayey loess. Differences between these sites (clay content, freshness, and roundness of quartz and feldspars) are due to the different watershed areas, variations in the source area, and weathering intensity.

**References**


