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Geoarchaeological prospection in the loess steppe: Preliminary results from the Lower Danube Survey for Paleolithic Sites (LoDanS)

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ABSTRACT

The Danube has long been considered a "highway" for the prehistoric hominin colonization of Europe. However, its role in the two most significant episodes of colonization – the first peopling of Europe in the Lower–Middle Pleistocene, and Late Pleistocene colonization by anatomically modern humans – is presently a matter of hypothesis based on the locations of only a few key archaeological sites. Much of Eastern Europe has a particularly low density of known sites, in part due to the thick loess deposits blanketing the region which provide a challenging environment for archaeological survey. Our project, the Lower Danube Survey (LoDanS), aims to discover new Paleolithic sites and to reassess previously identified sites in the southeastern Romanian loess steppe between the Danube River and the Black Sea. Here we present the preliminary results of our first three seasons (2010–2012) of geoarchaeological survey and excavation in the lower Danube basin. We revisit and reexamine the lithostratigraphic and lithic data available from previously known sites in the region. We also provide new luminescence ages from one of these sites, Cuza Vodă, and confirm its previously proposed Middle Paleolithic antiquity. We describe three newly discovered stratified Paleolithic sites, which together with existing sites confirm occupation of the Romanian loess steppe during the Lower, Middle and Paleolithic. Additional preliminary work at a nearby geological loess profile provides valuable paleoenvironmental context for hominin occupation of the region throughout the Pleistocene. Our investigations elucidate strategies and prospects for new site discoveries in open loess steppe landscapes such as those of Eastern Europe.

1. Introduction

The Danube has long acted as a highway for human migration throughout history. The fertile soils of the Danube basin were colonized by the earliest Neolithic farmers migrating from the Near East via the Balkans and into Central Europe; the invasions of the Byzantine and Ottoman empires followed the river's course; and even the Orient Express railway and contemporary long-distance road freight follow this general route. However, the role the Danube valley might have played in still earlier periods of human dispersal into Europe so far remains a matter of hypothesis and assumption. In particular, it is not known to what extent the valley served as a conduit for two of the most important demographic movements, namely, the earliest colonization by hominins (between 1.7 and 0.3 Ma), and the replacement of Neandertals by anatomically modern humans (AMH; between 45 and 35 ka).

One of the major reasons for the present lack of data is geological in nature. The thickest deposits of aeolian loess in Europe are found in Eastern Europe and the Lower Danube Basin in particular (Haase et al., 2007). Whilst these deposits provide a valuable archive of palaeoclimatic and paleoenvironmental change within the region extending to 1 Ma (Marković et al., 2008; Fitzsimmons et al., 2012; Marković et al., 2012), which can provide a useful context for the environmental conditions prevailing during colonisation episodes (Fitzsimmons et al., 2012), the thick sedimentary cover also means that sites are often deeply buried and difficult to find (e.g., Romanowska, 2012). During the Lower

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Pleistocene arrival of the first European hominins, the Lower Danube basin and much of the Romanian–Bulgarian Plain did not resemble the present-day loess steppe landscape. Instead, the basin was dominated by an extensive interconnected mega-lake system representing the transition between the regression of the Paratethys Sea and formation of the Danube and Tisza Rivers (Olteanu and Jipa, 2006; Gábris and Nádor, 2007), combined with the uplift of the southeast Romanian Dobrogean Plateau around 700 ka (Pfannenstiel, 1950; Bronger, 1976) and the increased contemporaneous uplift of the Carpathians (Buggle et al., 2013). Subsequent lake regression and river migration provided abundant source material for the initial early Pleistocene loess deposits (Pecsi and Schweitzer, 1993; Kovács et al., 2011), thereby facilitating the opening of the loess steppe landscape that presently characterizes much of Eastern Europe. The Eastern European loess steppe was never glaciated and maintained relatively stable environmental conditions throughout its history, which may have assisted hominin migration and occupation throughout the Paleolithic (Fitzsimmons et al., 2012).

Reconstructing the viability of potential migration routes is therefore dependent on an understanding of the geographic conditions at relevant periods in the past. As suggested by Fig. 1, Lower Paleolithic migrations may have followed a route into the Danube valley from Asia across the Russian Plains, a region which also comprises extensive loess steppe landscapes. However, at times the connections between Asia and Europe may have been limited by glaciations and sea level transgressions during glacial and interglacial stages respectively. The chronology and extent of the ice sheets of the Oka and Dnieper glaciations (Bolikhovskaya and Molodkov, 2006) is at this stage poorly understood, but would improve the ability to assess the viability of possible migrational connections between Asia and Europe during the Early and Middle Pleistocene. A lack of targeted studies and surveys aimed at answering these questions is probably one of the reasons why data for the earliest colonization in Eastern Europe are still scarce (for a critical review of some of the important sites, see Doronichev, 2008; Doronichev and Golovanova, 2010), preventing more precise examination of potential colonization routes or cultural traditions.

An examination of migration routes during the Middle to Upper Paleolithic transition is somewhat better served by the data. The particularly early dates for the Upper Paleolithic Aurignacian, from several sites in Central Europe such as Willendorf in Austria (Nigst, 2006; Nigst and Haesaerts, 2012) and Hohle Fels and Vogelherd (Conard and Bolus, 2008) in Southern Germany, suggest rapid expansion of AMHs from the Balkans along the Danube towards Western Europe (Fig. 2). This route is often referred to as the “Danube Corridor” (Conard and Bolus, 2003, 2008), and the validation of such a hypothesis requires the presence of the oldest sites (proto-Aurignacian or perhaps Bohunician) in the southern Balkans. This is partly confirmed by sites such as Bacho Kiro and Kozarnika in Bulgaria (Sirakov et al., 2007), and further supported by the findings of the oldest modern human skeletal material in the Banat region of Romania, at Peştera cu Oase (Trinkaus et al., 2003), as well as by other recently revisited early Upper Paleolithic sites such as Româneşti-Dumbrăviţa and Coşava in the Romanian Banat (Sitlivy et al., 2014).

Early dates for the Upper Paleolithic occupation of the Russian plain (e.g., Kostenki 14, Sinitsin, 1996) suggest a second potential route during MIS 3 within the Late Pleistocene (see Fig. 2). This route is proposed to have originated in the Levant, moving from the southern Balkans along the Black Sea coast northward along the major rivers of the Dnieper, Volga and Don (Mellars, 2004: Fig. 1; 2006). If this additional route into Eastern Europe did exist during MIS 3, then the loess steppe of southeastern Romania between the Black Sea and the Danube would have provided another useful

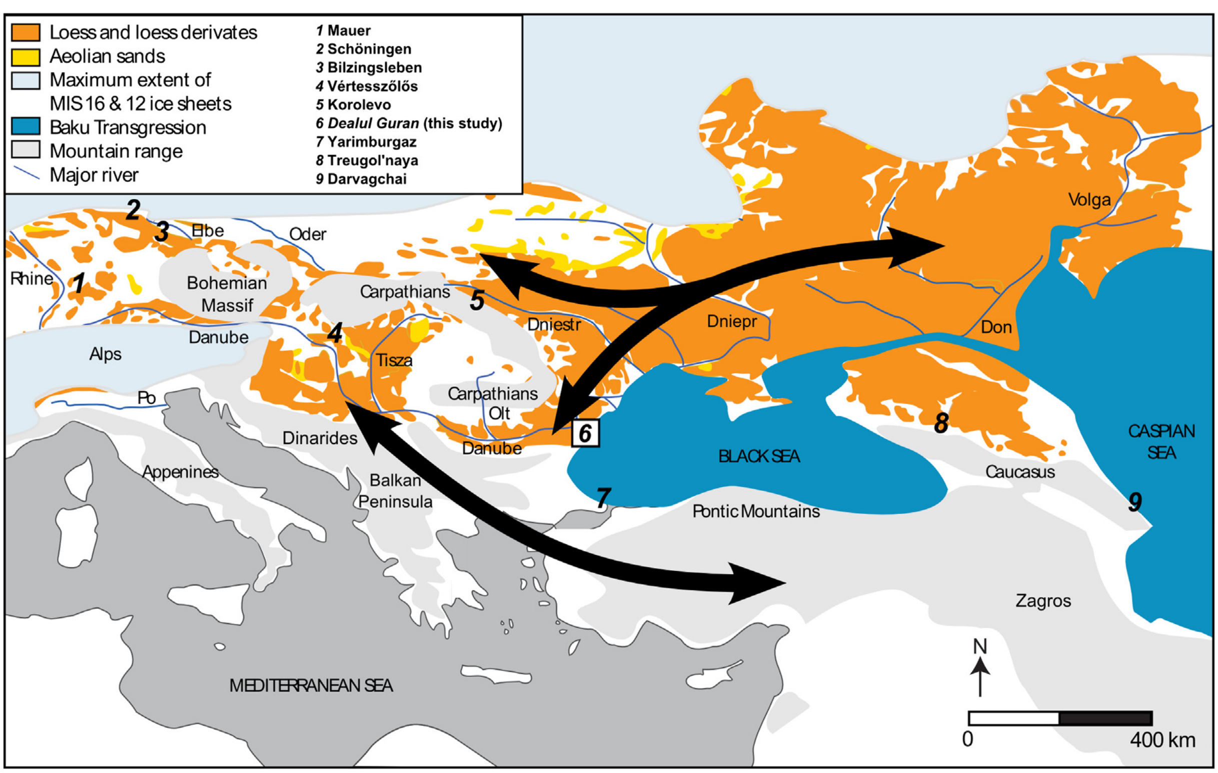

Fig. 1. Hypothesized migration routes into and out of Europe during the Middle Pleistocene. The location of known Lower Paleolithic sites in the region, the distribution of loess cover (after Haase et al., 2007), the approximate maximum extent of the MIS 16 and MIS 12 ice sheets (after Velichko et al., 2006), and the MIS 13–11 Baku Transgression affecting the Black and Caspian Seas (Dolukhanov et al., 2009), are also shown. Present-day coastlines of the Mediterranean are shown.

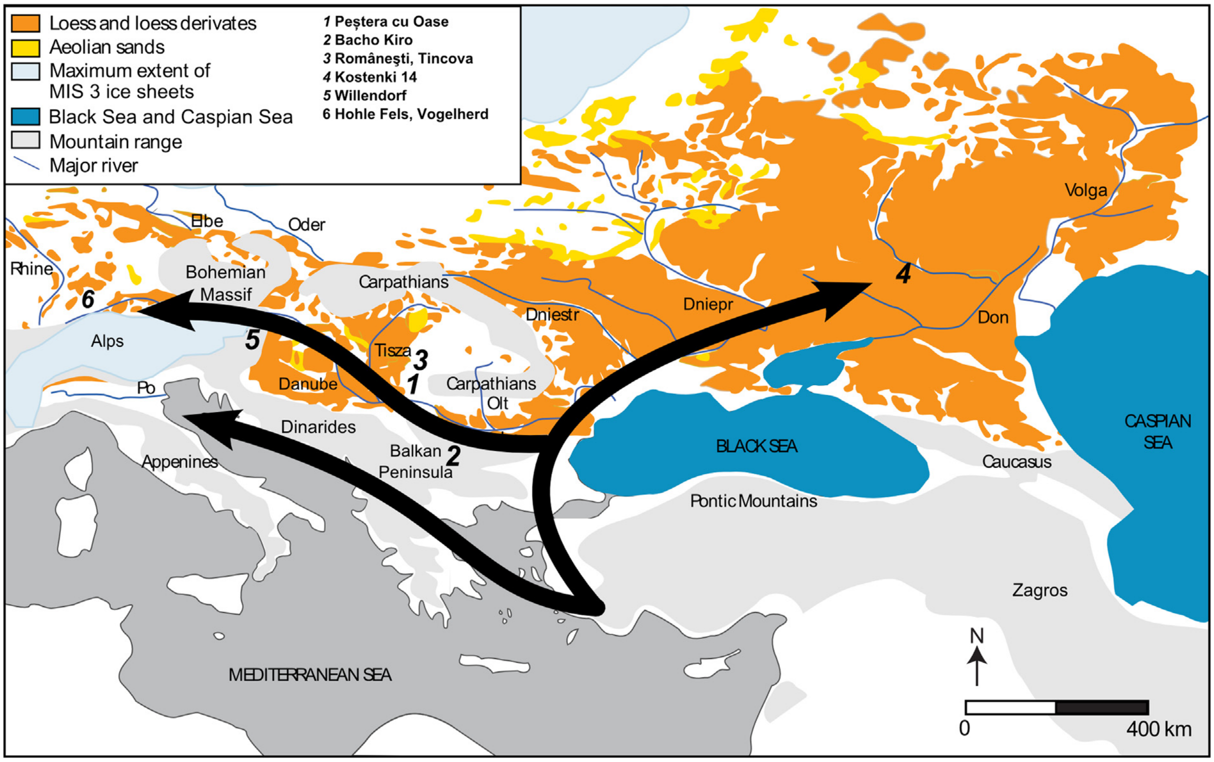

Fig. 2. Hypothesized migration routes into and out of Europe during the Late Pleistocene. The location of known Upper Paleolithic sites in the region, the distribution of loess cover (after Haase et al., 2007), and the approximate maximum extent of the glaciers during MIS 3, are also shown. Present-day coastlines of the Mediterranean are shown.

transition zone for the movement of people in both directions. Periodic contact between populations in the Crimean Peninsula and the Dobrogea region of southeastern Romania during the Pleistocene would have been further facilitated by the cyclic exposure of a land corridor as a consequence of regression of the Black Sea during glacial phases (although complicated by local tectonic activity) (Ross et al., 1970; Giosan et al., 2009). The landscape, climate and ecology of Dobrogea and Crimea are strongly similar, comprising an identical steppe fauna (Petculescu and Ştiucă, 2008), and the presence of known human subsistence species the European Ass (*Equus hydruntinus*) and Saiga antelope (*Saiga tatarica*), which further support the hypothesis for a connection between human populations in the two areas.

The rationale of the Lower Danube Survey (LoDanS) for Paleolithic sites was to discover new archaeological sites in this region in order to better understand hominin migration into Europe throughout the Pleistocene. It was clear that such a study was needed, given the geographically important position of the Lower Danube basin as a potential crossroads for hominin dispersal throughout the Paleolithic, and the present paucity of known sites in the region. The well-preserved loess archives of the region provide a valuable paleoenvironmental framework for archaeological discoveries, and the challenge of uncovering deeply buried sites beneath the loess can be overcome by strategic surveys targeting regions of thinner cover. The study comprised three components: revisiting and reassessing the available data from previously discovered sites; targeted and systematic geoarchaeological survey to discover new archaeological sites; and an examination of paleoenvironmental change and the context for hominin dispersals through the study of a thick geological loess profile within the study region. This paper presents the results of three seasons of survey and excavation fieldwork (2010–2012) in the Dobrogea region of southeastern Romania.

2. Previous work

The Paleolithic of Dobrogea is best known through the work of Alexandru Păunescu, from the Institute of Archaeology of the Romanian Academy, who undertook a series of surveys and test excavations throughout the region during the 1960s–1990s. Most of the sites known were found during the construction of the Danube–Black Sea Canal, which artificially widened an existing tributary of the Danube, the Carasu River. Păunescu's inventory contains both Upper and Middle Paleolithic sites; no Lower Paleolithic finds were documented. Reassessment of lithic material collected by Păunescu by one of the authors of this study (Doboş, 2010) suggested a bias for retouched tools in the collection, but also taphonomic bias in their original interpretation (e.g., damage interpreted as intentional retouch). Since none of the sites were dated radiometrically, most of the chronological assignments were based solely on lithic typology and should therefore be considered preliminary. Some of the fossiles dirécteurs, when collected at the surface, cannot be unambiguously ascribed to a sufficiently small time slice, since they occur in multiple periods. A particularly relevant example is offered by various backed microliths with atypical forms, which could appear in several Upper Paleolithic industries, from the proto-Aurignacian to the Epi-Gravettian. Doboş's study therefore highlighted the need both for direct dating and reassessment of the contexts of existing sites, and for finding new stratified sites.

The most important known stratified site in the region was the open-air site of Mamaia-Sat, located on the coast directly north of the city of Constanţa. Mamaia-Sat was rescue-excavated by Păunescu prior to the construction of a resort on the site (Valoch, 1993; Păunescu, 1999). It delivered two relatively rich archaeological layers, separated by ≈2.5 m of sterile loess. The abundant lithic materials included Levallois as well as non-Levallois technology and bifacial/leaf points. Bifacial tool assemblages are known from other sites in the Balkans, such as Musselievo in Bulgaria (Sirakova and Ivanova, 1988) and are typical of the Crimean Middle Paleolithic (Chabai et al., 2004). The classification of these assemblages in the Balkans is, however, fraught with methodological issues, whereby genetic relationships have been proposed on the basis of mere morphological similarity (but see Richter, 1997, 2004; Uthmeier, 2004 for a re-evaluation of the meaning of bifacial technology in the late Middle Paleolithic of Central and Eastern Europe; Jöris, 2006; Iovita, 2009). Although the site of Mamaia-Sat was never directly dated, profile drawings suggest the upper archaeological layer to correspond to the uppermost major paleosol complex below the surface, with lower archaeological layer occurring within an underlying reddish paleosol (Păunescu, 1999, Fig. 44). Based on current knowledge of soil characteristics and stratigraphy in the loess of this region (Fitzsimmons et al., 2012), the archaeological layers could reasonably be correlated with marine oxygen isotope stage (MIS) 5 (the last interglacial) and MIS 7–9 respectively.

Several cave/rockshelter sites are known in central Dobrogea (the northern part of Constanţa county). These include the recently re-excavated La Adam cave (Dumitrescu et al., 1963; Dobrescu et al., 2008), which featured a small collection of Middle Paleolithic lithic material, an unerupted M1 assigned tentatively to *Homo sapiens* (Necrasov, 1971), and cave fauna. Other cave sites in the vicinity include Peştera Bursucilor (Badger Cave), which contained some possible Dufour bladelets (Terzea, 2000) and Peştera La Izvor (or Peştera Cheia La Izvor, Păunescu, 1999: 93), which contained mainly Middle Paleolithic material. The majority of remaining finds are surface collections, sometimes with a description of the nearby geological profile, but with no in situ archaeological layers discovered during the sondages. Other known sites such as Castelu, Cuza-Vodă, and Dealul Peşterica, all of which yielded relatively large lithic collections, were revisited as part of the LoDanS project (Section 4.2).

3. Materials and methods

3.1. Strategy

The archaeological survey aimed to systematically locate sites based firstly on geomorphic and geological context, combined with local knowledge of concentrations of lithic material at the surface. Prospective sites were then tested through small sondages. This strategy combines the advantages of surveying in caves and rockshelters, which form natural habitation locations, with the more uncertain strategy of surveying loess deposits for open air habitation contexts (see Fig. 3). The aim was to obtain a more complete picture of hominin occupational strategies within an environmental context.

The geology and geomorphology of Dobrogea is similar to that of the Crimean Peninsula, which has yielded a large number of Paleolithic sites (e.g., Marks and Chabai, 1998; Chabai et al., 2004). The bedrock geology of the central and southern Dobrogea is dominated by multiple marine limestone units from Jurassic to Miocene age, originally deposited as sediment beneath the Tethys Sea (Avram et al., 1993; Harzhauser and Piller, 2007). Several of these limestones form karst and contain caves and rockshelters, which are consequently more suitable for archaeological survey. These include the lower Cretaceous Barremian and Aptian limestones, which form compact cliffs, and the upper Cretaceous Cenomanian limestone, which contains in situ flint nodules useful as raw material sources. The mid-Miocene Sarmatian limestone is friable and prone to collapse, and was not considered as suitable as the other limestone units. Moreover, most of the rockshelters and small caves in Sarmatian limestone that were identified by the field teams preserved no sediment at all or had thin deposits related to contemporary pastoral activities Consequently, outcrops of the karst limestone units were targeted for archaeological survey, both where they outcrop as cliffs, and where sediment cones accompanied by boulders indicate collapsed rockshelters which may have acted as sediment traps.

The limestone bedrock of the Dobrogea plateau, however, is blanketed by loess of variable thickness, and has been incised by valleys subsequently infilled by alluvium associated with the Danube River and its tributaries. Both loess and alluvial infill are thinnest in the upper parts of tributary valleys, and along the upper parts of valley slopes. Therefore, the survey first identified likely outcrops of the limestone units of interest, and then focused on the upper slopes of valleys incising into the plateau where the karst limestones occurred. These contexts were considered to carry the highest potential for preservation, relatively close to the surface, of Paleolithic occupation sites.

3.2. Karst survey (2010)

The archaeological survey was carried out using 3 teams of 3–4 people who explored the targeted areas of the landscape, radiating from a central meeting point on the plateau. Survey areas were chosen in advance using geological and topographic maps, as well as aerial views downloaded from Google Earth. Teams recorded all points of interest with a hand-held GPS unit. Teams were provided with digital cameras, the GPS units and cameras being synchronized for time, therefore it was possible to geo-tag every photograph using each team's GPS tracks from that day (using GPSPhotoLinker software). Each team was provided with a notebook, in which observations about the points were recorded, as well as time-information for geo-tagging the photos in case the GPS units failed. The survey methodology is modified from McPherron and Dibble (2003) and Olszewski et al. (2010).

The most promising sites were then investigated by test excavations, which were carried out with picks and shovels, continuing with trowels and precision tools when cultural layers were encountered. The vertical position of the excavated artifacts was for the most part recorded in spits. Unfortunately for a situation with deeply buried cultural layers such as the Romanian loess steppe, permits only allowed for testpit dimensions of 2 × 1 m, which constrained the maximum depth of sondages to 3 m for safety reasons. This led to difficulties if rockshelter roof fall was encountered blocking access to deeper deposits, or if the loess deposits were too thick, and may ultimately have prevented the discovery of more deeply buried sites. All testpits were backfilled over the top of a layer of plastic with the pit ID and date placed on the bottom.

Only one of the discovered sites (Dealul Guran) has so far undergone full-scale excavations (Iovita et al., 2012). For these excavations, the documentation methodology followed the system of McPherron and Dibble (2002).

3.3. Loess survey (2012)

In the 2012 field season, a single team of 2–3 people carried out another foot survey within southern Dobrogea (Constanţa county), and focused on documenting as many visible loess profiles on the Danube tributaries as possible within the geographic boundaries of the commune of Peştera, in accordance with the extent of the permit. This strategy was adopted following the recent discovery in southern Romania of a number of Campanian Ignimbrite (CI) tephra deposits (Veres et al., 2012; Fitzsimmons et al. 2013), deriving from a volcanic eruption which occurred in the Phlegrean Fields of Italy ca. 39 ka (Deino et al., 1994). Focusing on the CI tephra horizon as a

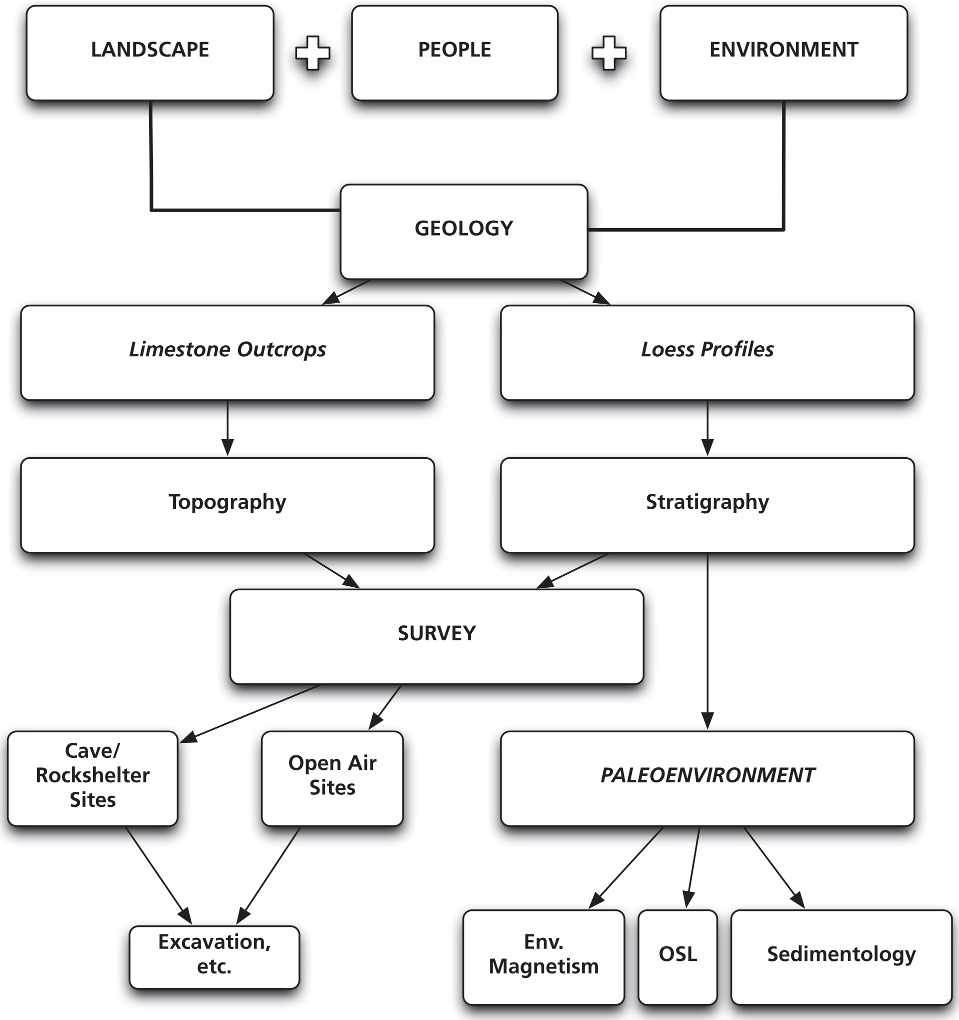

Fig. 3. Flow diagram summarizing the geoarchaeological survey strategy developed by the LoDanS project.

chronological marker which approximately corresponds to the Middle to Upper Paleolithic transition, and the arrival of AMH into Europe (e.g., Lowe et al., 2012), focused the time period of the surveyed sites. The prospection work was carried out at the same time as excavations at the site of Dealul Guran (Section 4.1.1). This, combined with the geographic restriction on test excavations, limited the scope of the survey largely to documenting in-situ cultural materials found in loess profiles. At one site discovered within Peştera commune (Dealul Peşterica: Section 4.2.3), test excavations were carried out and the location of artifacts was recorded individually using measuring tape.

3.4. Chronostratigraphic methods

Luminescence dating studies were undertaken at one known (Cuza Vodă) and three newly discovered (Dealul Guran; Dealul Peşterica; Lipniţa) archaeological sites, in addition to samples collected from a nearby loess section (Urluia) to provide a chronostratigraphic context for paleoenvironmental change in the region. Luminescence samples were collected by driving 4 cm diameter, 10 cm long stainless steel tubes horizontally into cleaned vertical exposures. Additional samples were collected for laboratory measurements of dose rate.

The laboratory protocol for the Dealul Guran samples, and the dating results, have recently been published (Iovita et al., 2012). This paper describes the protocols used for the Cuza Vodă samples, for which the ages are presented in this paper. In the laboratory, the sample tubes were opened and the sediments processed under low intensity red light. The central portion of the tubes was removed for dating. Remaining material was weighed, dried and weighed again to calculate the moisture content. Samples were processed to isolate the fine-grained (4–11 μm) polymineral component, as this most likely contained the highest proportion of loess with the best chance of complete resetting of the luminescence signal during deposition. This process followed a protocol of sieving, digestion in dilute hydrochloric acid and hydrogen peroxide to remove carbonates and organic components respectively, then by sediment settling following agitation in an ultrasonic bath.

Equivalent dose (De) measurements were undertaken on 24 × 10 mm discs using the single-aliquot regenerative dose (SAR, Murray and Wintle, 2003) protocol on a Risø TL-DA-20 reader, assembled with a D410 filter (Bøtter-Jensen et al., 2000). The (elevated-temperature) post-IR $IRSL^{290}$ protocol (Thiel et al., 2011; Buylaert et al., 2012) was used, as post-IR IRSL signals appear to show less fading than standard polymineral IRSL signals (Thomsen et al., 2008; Buylaert et al., 2009), and are therefore less dependent on fading corrections. The samples yielded broadly Gaussian distributions (Supplementary Fig. 1), although relatively few discs from sample EVA1044b yielded simple exponential growth and were not saturated with respect to dose; the age of this sample should therefore be interpreted with caution. The central age model of Galbraith et al. (1999) was used to calculate the De values of all samples.

Dose rates were calculated using high resolution germanium gamma spectrometry (HRGS) analysed at the Felsenkeller in Dresden, Germany, for the gamma component, and beta counting for the beta component. Beta components calculated from the HRGS analyses using the conversion factors of Adamiec and Aitken (1998) yielded values within 10% of the beta counting results. Consequently these two analytical techniques were considered comparable. The HRGS analyses showed little evidence of potential disequilibrium in the uranium series decay chain, consistent with predominantly aeolian sedimentary deposits in a low rainfall area. The cosmic ray dose rate component was calculated using the formulae of Prescott and Hutton (1994).

4. Results

The 2010 archaeological survey yielded 59 data points (Fig. 4), of which:

20 were surface find-spots of lithic material;
35 were locations of rockshelters with sediment or other places deemed suitable for testing; and
4 were already known archaeological points of interest (either surface-find localities or stratified sites), which were re-evaluated for future research (Fig. 8).

From these, 5 different localities were chosen for test-excavations. The testpits, 2 × 1 m in dimension, averaged a depth of 1.87 m. One new site was discovered (Dealul Guran, see Section 4.1.1 below) and one of the known sites (Cuza Vodă, see Section 4.2.2) was evaluated as potentially interesting for future excavations. Both of these sites were sampled for luminescence dating. In addition to the archaeological survey, a long loess-paleosol sequence was discovered near the village of Urluia, and sampled for luminescence dating and environmental magnetism (see Section 4.1.3 below), with the view to provide a reference paleoenvironmental framework for the region.

The 2012 loess survey yielded 162 data points (profiles), out of which 12 locations yielded surface lithics (see Fig. 4 below). Two of these were identified as stratified sites (Dealul Peşterica and Lipniţa). Unfortunately, because test excavations were authorized only within the geographical boundaries of Peştera commune, only Dealul Peşterica was tested, since Lipniţa lies beyond those limits. At both Lipniţa and Dealul Peşterica, samples were collected for micromorphological analysis and for luminescence dating; these samples are currently being processed.

4.1. New sites

4.1.1. Dealul Guran and lithic reduction landscapes of the Peştera valley

Perhaps the most exciting discovery of the LoDanS project was the site of Dealul Guran, Romania's first and only known Lower

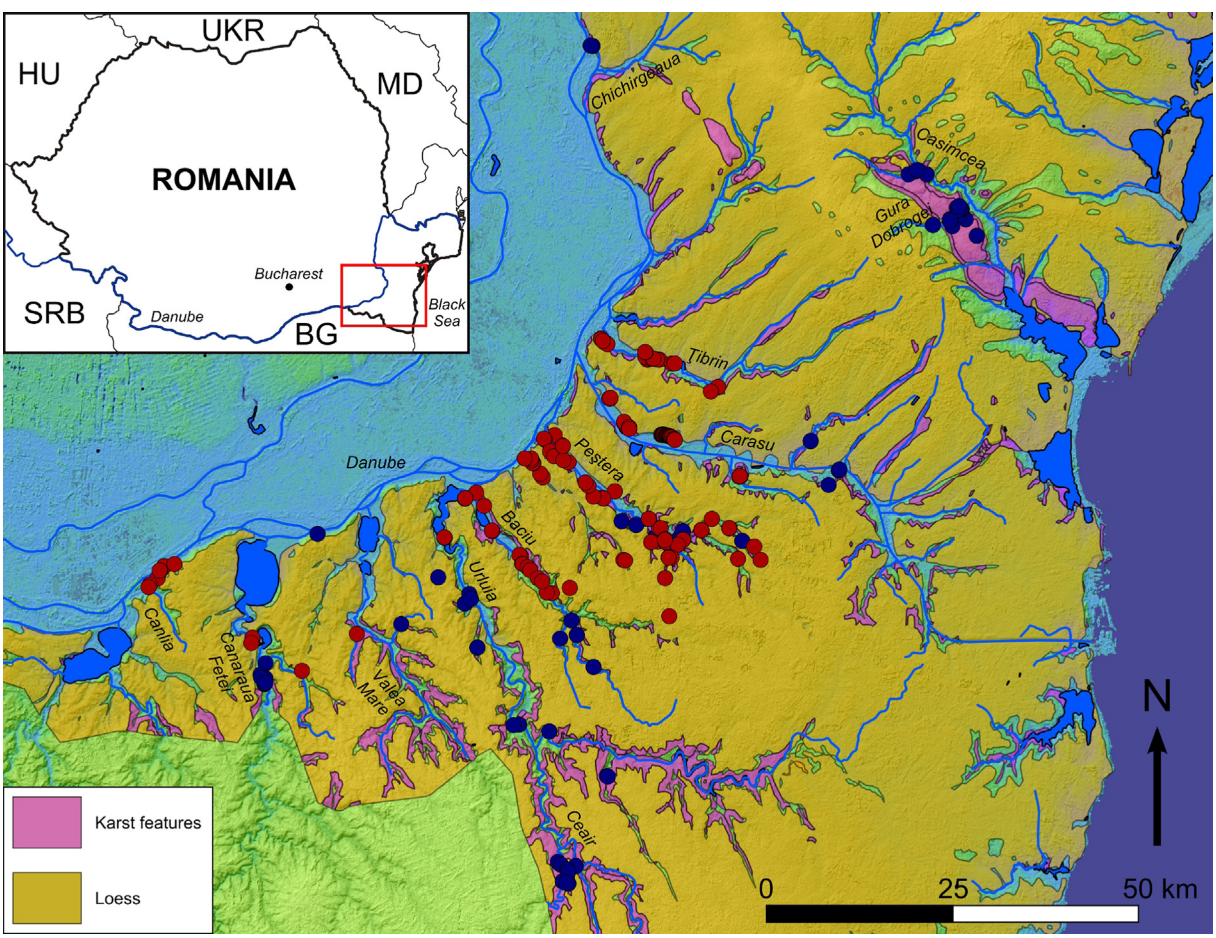

Fig. 4. Sites of interest identified during the 2010 (blue) and 2012 (red) survey seasons. The blue points represent either surface lithics or rockshelters with sediment, whereas the red points represent loess profiles. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Paleolithic site (Iovita et al., 2012). Dealul Guran is a northeast-facing collapsed rockshelter approximately 40 km west of the Black Sea, and about 30 m above the present Peştera valley (52 m a.s.l.), adjacent a tributary of the Danube River (see Fig. 5). The site stratigraphy comprises a mixture of redeposited sediments closely reflecting the Cretaceous–Paleogene bedrock sequence from which they are derived, combined with a component of far-travelled aeolian loess. Raw material, in the form of flint nodules, is present within the in situ bedrock sequence. Hominin occupation of the site, preserved at three levels, was dated using luminescence techniques (OSL, IRSL, and post-IR IRSL) (Iovita et al., 2012). The two lower archaeological units occur within a sedimentary unit indicating relatively humid conditions, interpreted as corresponding to an interglacial. This unit yielded three statistically overlapping ages of 320 ± 21 ka, 388 ± 36 ka and 392 ± 23 ka, and was therefore interpreted to most likely correspond to MIS 11. These ages clearly establish Dealul Guran as the oldest archaeological site in Romania and one of the oldest securely-dated Lower Paleolithic sites in Eastern Europe. These lower sediments are capped by an unconformity, and overlain by three stratigraphic units, dating to MIS 3 and 2 (32.1 ± 2.0 ka and 17.1 ± 1.1 ka respectively). The uppermost archaeological layer lies within the younger, more loess-rich layer corresponding to MIS 2. The core-and-flake lithic assemblages of the lower layers exhibit almost no edge damage and seem to preserve the entirety of the chaîne opératoire, with decortication and cobble-testing being the main tasks. The lack of retouch tools and diagnostic technological features probably reflects the abundance of high-quality raw material present at the site and presents an interesting contrast to the majority of Lower Paleolithic sites of similar age in Central and Eastern Europe (Iovita et al., 2012).

The hillside around the Dealul Guran site exhibits large numbers of lithic artifacts on the surface, sufficiently far away from the stratified site to suggest that knapping activities were more or less spatially continuous across the landscape. A similar context was discovered near the village of Remus Opreanu (see Fig. 8) during the 2012 season. Several collection points were already known near the village of Remus Opreanu, which is located on the steep north-eastern slope of a small tributary valley which flows into the Carasu River, to the west of Medgidia city. In 1984 Eugen and Păunescu found 49 lithics at a vineyard north-east of the village (Păunescu, 1999: 185). Păunescu attributed half of the lithics to the Mousterian and the other half to late Upper Paleolithic on typological grounds, and noted several microlithic tools. We observed hundreds of surface lithics scattered across the hillside, consisting of unworked to slightly reduced flint nodules, and numerous unretouched flakes. The lithic raw materials are, as at Dealul Guran, part of the underlying bedrock units, which are part of the same Cretaceous–Paleogene sequence as in the Peştera Valley. No retouched pieces were discovered during the survey. The Remus Opreanu area, like at Dealul Guran, has a relatively thin loess cover, which suggests that it also may represent a landscape of overlapping instances of casual raw material exploitation spanning long periods of time. However, the surface morphology of the hillslope suggests a lack of potential rockshelters which may have supported

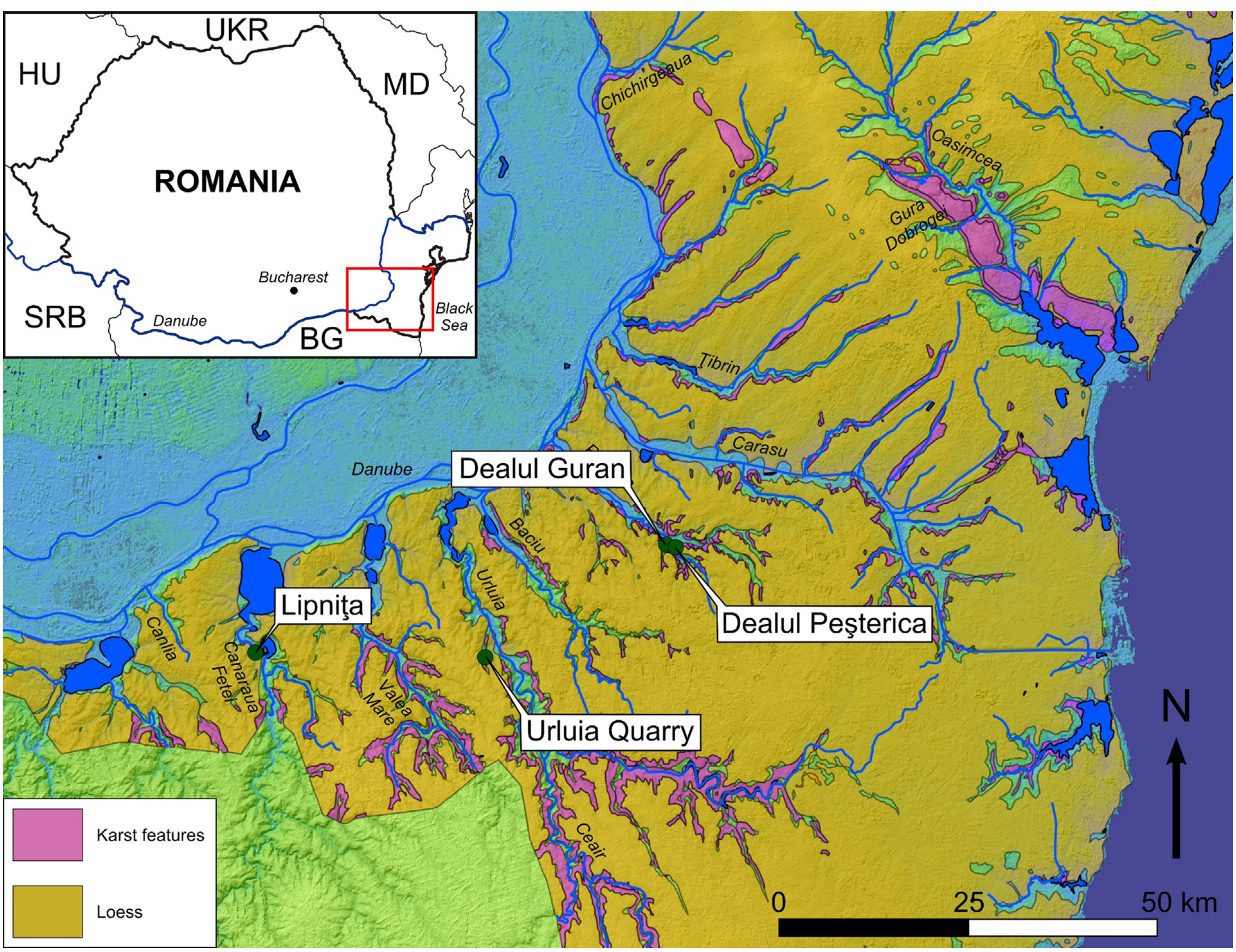

Fig. 5. Location of the three archaeological sites discovered by the LoDanS survey: Dealul Guran, Dealul Peşterica, and Lipniţa. The geological and paleontological site of Urluia is also shown.

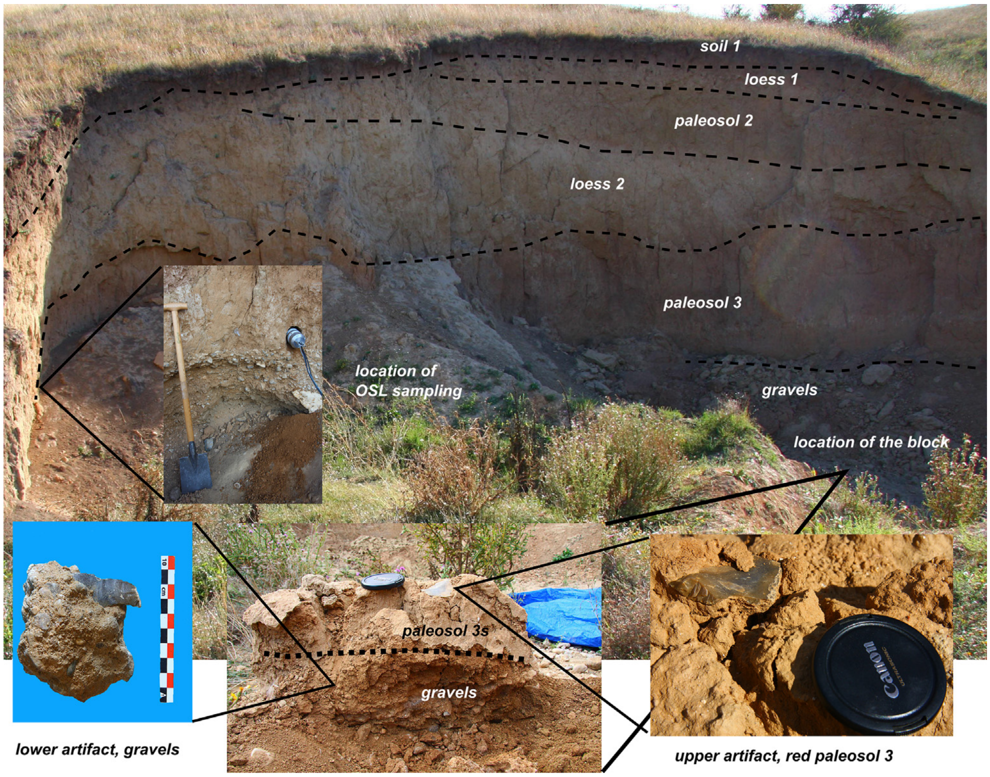

Fig. 6. View of the profile at Lipnita. The inserts show the sediment block and both of the artifacts that are still embedded in the matrix, as well as the location of the OSL sample for obtaining a minimum age for the lithics.

more intensive occupation. We therefore hypothesize that the majority of these lithic scatters represent palimpsests rather than eroded stratified sites.

4.1.2. Lipnița

Two flakes were recovered from a large block of sediment found at the base of a small loess quarry near the village of Lipnița (altitude 30 m a.s.l.) in 2012 (see Fig. 6). The block was probably removed by a shovel excavator used to extracting loess for construction. However, it was sufficiently well indurated to preserve the original stratigraphic sequence. Consequently, the original stratigraphic position of the block could be reconstructed with some confidence. Both the block and the stratigraphic exposure indicate a sequence of upward fining fluvial gravels and cobbles, overlain by a reddish paleosol, which is underlying paler, less well consolidated loess. The two lithics, both of which had relatively fresh surfaces, were both located at the contact between the fluvial gravels and overlying red paleosols, the lower one being discovered when the block was cut in two in the office for later micromorphological analysis. We therefore collected luminescence dating samples from the quarry wall, and also brought back a portion of the block itself both for dating and micromorphological study. As the luminescence studies are still in preparation, it is difficult to estimate the age of the lithics, but their location in the stratigraphy below two loess-paleosol packages indicates that they might be older than the last interglacial.

4.1.3. Urluia

In addition to the archaeological survey, a long loess-paleosol sequence comprising at least six glacial–interglacial cycles was identified near the village of Urluia (Fig. 7). The sequence, only briefly mentioned in the literature (Munteanu et al., 2008), is approximately 25 m thick and overlies a 1–2 m thick sequence of lacustrine muds corresponding to the early Pleistocene lake phase. The entire sedimentary package is underlain by lower Cretaceous limestones. Pachyderm and bovid skeletal remains are visible at least four locations within the section.

This site was chosen for detailed paleoenvironmental investigations to provide context and a chronostratigraphic framework for hominin occupation of the region. The Urluia quarry has been sampled for luminescence dating, environmental magnetism (e.g., Hambach et al., 2008), grain size and geochemical analysis. Its significance as a chronostratigraphic sequence for the region is further enhanced by the presence there of a particularly thick layer of rapidly-deposited ash from the Campanian Ignimbrite eruption (Fitzsimmons et al., 2013). Further studies in the near future will assess the eruption's impact on local human populations.

4.2. Old sites revisited

Several previously identified sites were revisited during both seasons. None of these sites were fully re-excavated as part of our study; the aim was to reassess their potential for further archaeological investigations. At Dealul Peșterica, which was previously registered as a surface collection point, we undertook test excavations to locate the likely stratified layer which yielded the surface material. Otherwise, the potential of old sites for future study was evaluated in terms of lithic accumulations at the surface, and for geological and geomorphological context by cleaning existing sections (Fig. 8).

4.2.1. Cuza Vodă

Cuza Vodă is a previously identified site situated 3.5 km north of the Danube–Black Sea canal, approximately 400 m east of a cement quarry, and a similar distance south of the village of Cuza Vodă (altitude 31 m a.s.l.). The site lies within an excavated ditch

Fig. 7. View from the southeast of the loess profile at the Urluia quarry.

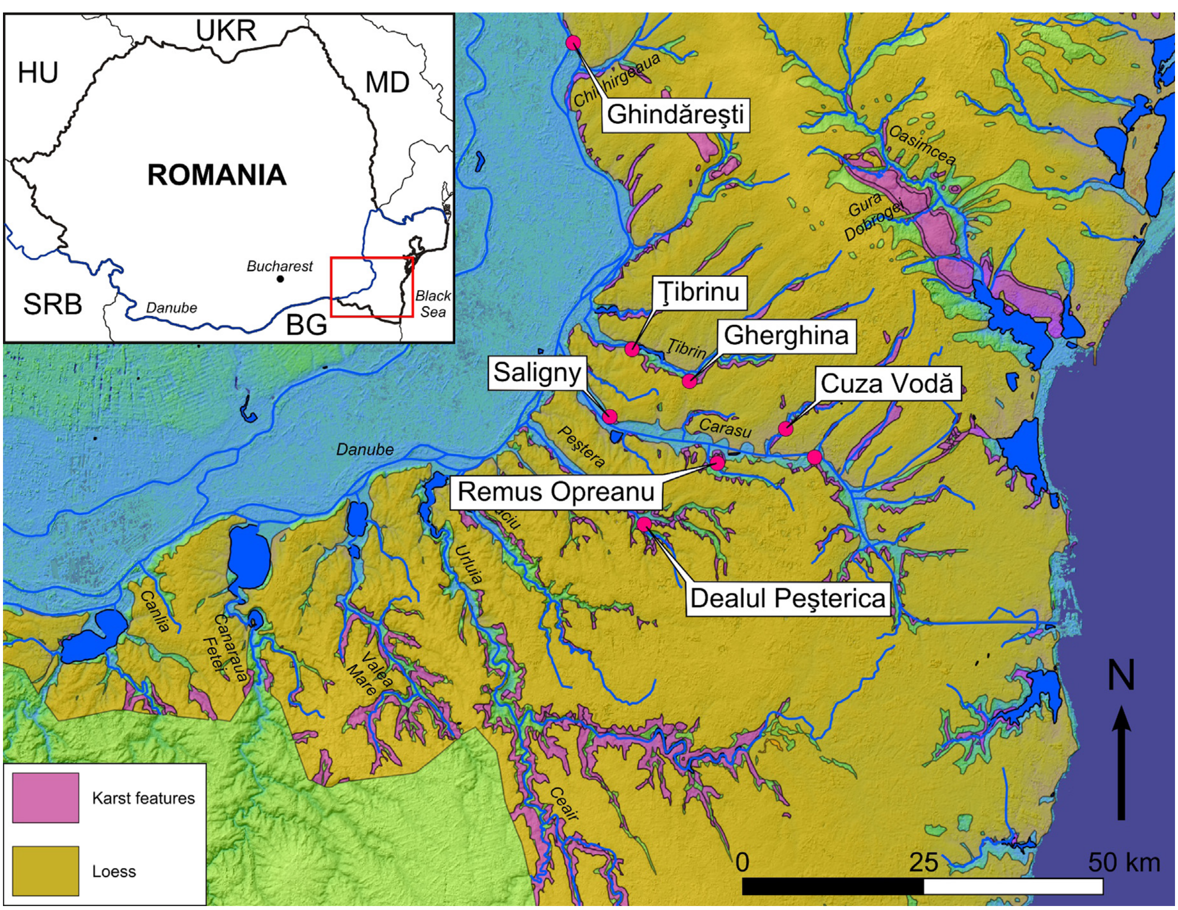

Fig. 8. Location of previously identified sites, revisited in this study. Note: Dealul Peşterica exists in the National Register of Archaeological Sites, and is thus technically an old site. However, it was not previously tested beyond surface collection and therefore appears on both maps.

associated with quarry operations, running east–west and perpendicular to the west-facing slope (Fig. 9). Although there is some surface slumping and redeposition associated with the quarry activities further upslope, the ditch nevertheless preserves in situ deposits of loess and colluvial sediment.

Earlier work consisted of the collection of more than 1000 lithic tools derived from sediment disturbed by kaolinite extraction activities by Păunescu and Eugen between 1991 and 1995. They described the artifacts to have derived from a 0.7–1 m thick yellowish loess layer which overlies a unit of mixed colluvial and loess of indeterminate thickness. The lithic assemblage was described as Middle Paleolithic with a Levallois component (IL = 9.2%, ILty = 24.6%, 15/57 Levallois cores) (Fig. 10). The artifacts are rolled and white-patinated. Truncated-faceted pieces and Kombewa cores are also present, but the proportions of other tools are difficult to estimate, due to extensive edge damage. The presence of such flaked flakes in a context of raw material abundance lends further support to the theory that small flakes were perhaps a desired end-product in Middle Paleolithic, rather than a result of a recycling response to raw material scarcity (Dibble and McPherron, 2006).

The LoDanS team visited the Cuza Vodă site in 2010 and identified a number of surface lithics, in addition to a single in situ artifact found within the stratigraphic exposure of the ditch, at the contact between the two main geological units. An initial stratigraphic description was made and three luminescence dating samples collected from sediment bracketing the contact from a suitable section nearby where the lithic was found.

The stratigraphy at Cuza Vodă comprises three main units (Fig. 11A). The lowermost exposed unit, C, comprises mostly colluvium with a substantial component of loess. Unit C is orange–red silty clay (in the web version), which contains frequent colluvial gravels and cobbles up to 5 cm in diameter. The cobbles include frost-fractured honey-colored flint, some of which may represent worked lithic artifacts. Unit C may also contain lithic artifacts, although none were unequivocally identified within the exposed profile during the 2010 visit. A well-developed carbonate-rich, pale soil is developed in the upper 10 cm of unit C. The one confirmed lithic artifact (a core fragment) was identified at the contact between unit C and the overlying unit, B, confirming the stratigraphic position of the in-situ lithics as described by Păunescu (1999). Unit B contains predominantly silty buff-colored loess with a minor

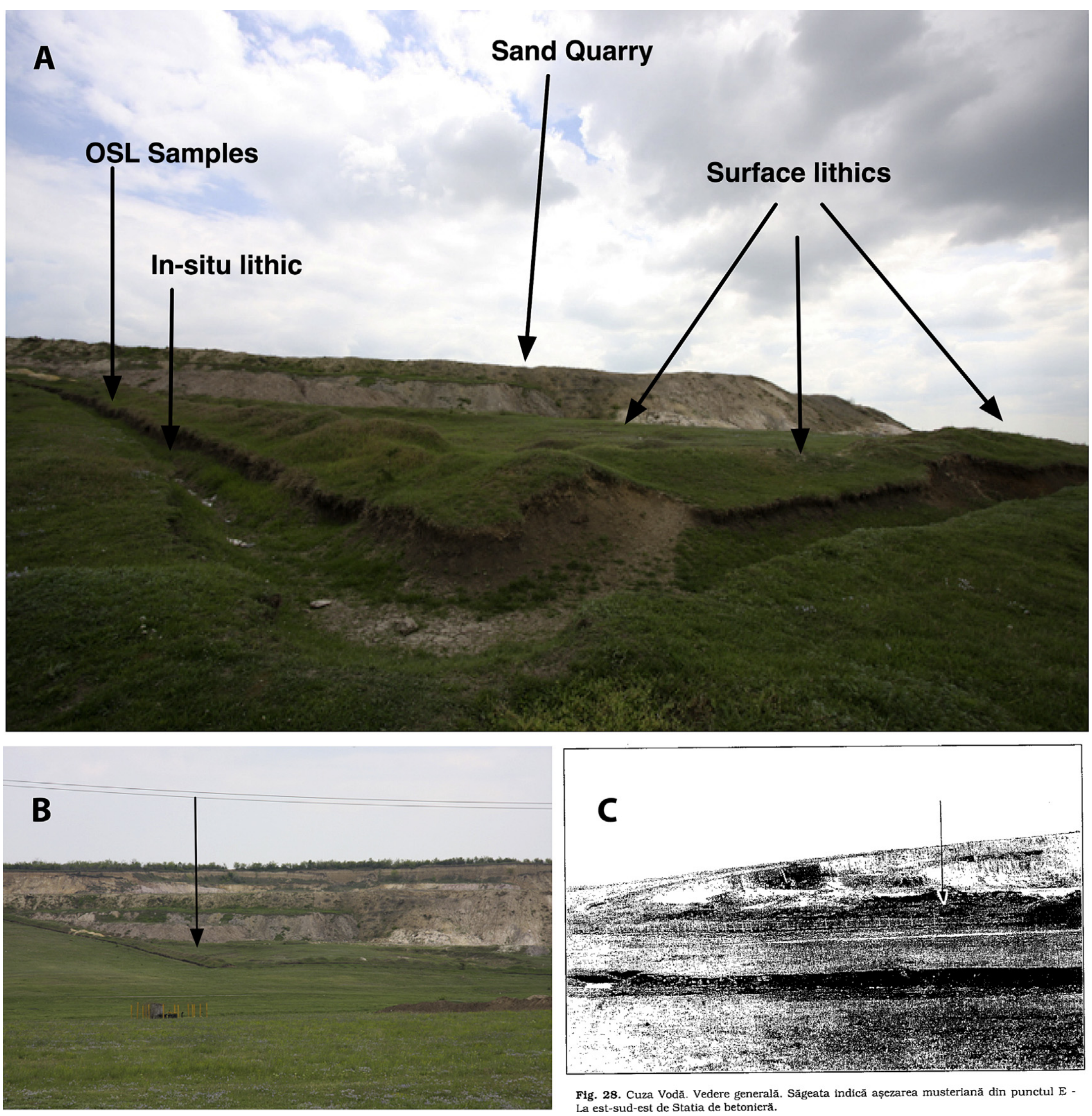

Fig. 9. (A) View and context of the Cuza Vodă site. (B) The quarry in 2010 (photo credit: this study). (C) Quarry stratigraphy in 1991 (photo credit: Păunescu, 1999).

colluvial component, indicating an increasingly aeolian-dominant sedimentation regime through time. Gravels are present, although increasingly rare, throughout unit B. The upper part of this unit is darker, representing organic enrichment and pedogenesis. The uppermost layer, A, is a brown–grey humic soil dominated by loess, although with a colluvial component as indicated by the presence of gravels and cobbles to 3 cm in diameter. In situ honey-colored lithic artifacts are present both on the surface and within unit A, although it is unclear whether they were deposited at the site, or transported through colluvial processes.

The results of the luminescence dating study at Cuza Vodă are shown in Table 1. The luminescence dating of units B and C at Cuza Vodă yielded age estimates of 54.7 ± 8.0 ka, 94.7 ± 13.9 ka and 121 ± 19 ka, respectively. The oldest age yielded a number of saturated aliquots with respect to dose, but nevertheless lies within two standard deviations of the younger age from unit C; given the substantial colluvial component of this unit, this age should be interpreted with some caution. Nevertheless, since the samples were collected from sediment bracketing the contact at which the confirmed lithic was found, the antiquity of the site can be constrained with reasonable confidence between ~95 and 55 ka, most likely within MIS 4. This is consistent with a late Middle Paleolithic age for the occupation at Cuza Vodă.

The paleoenvironmental conditions prevailing at the precise time of occupation of the site cannot be confirmed, since the lithic artifact was found at the contact between two units. However, it appears that the preceding period, corresponding to MIS 5, provided conditions humid enough for substantial colluvial/hillslope deposition, followed by a phase of more stable conditions responsible for formation of the carbonate-rich soil. Increasing concentrations of loess within the overlying unit suggest generally cooler, drier conditions, which is consistent with increasing loess accumulation in the lower Danube basin during the last full glacial cycle, and particularly from MIS 4 (Fitzsimmons et al., 2012).

4.2.2. Castelu

The Castelu site is located on a hill (Dealul Castelu/Cainar) found on the southern bank of the former Carasu River, currently replaced by the Danube–Black Sea channel, approximately 44 m a.s.l. Surface collection was carried out by Păunescu from 1971 to 1982, during which time he collected more than 300 lithic tools from the eroding sediment of the valley slope. Păunescu suggested that the artifacts may have come from a red paleosol observed within an erosional gully nearby the surface finds, which also contained flint cobbles and some flint tools (Păunescu, 1999: 80–86). The lithic assemblage analyzed by Doboş (2010: 127–140) was dominated by Levallois flakes and cores (IL = 29%; ILty = 35%, only 8 scrapers), and a relatively low flake to core ratio. However, the high percentage of tools may have been due to collector's bias toward more interesting pieces.

The LoDanS team visited the site in 2010 and found additional lithic material on the surface of the hill. However, no prospective areas where in situ deposits might still be preserved were identified. Castelu has low potential for further research.

4.2.3. Dealul Peşterica

The Dealul Peşterica site is located on the hillslope opposite Dealul Guran to the north-west of Peştera village, at an altitude of approximately 39 m a.s.l. (see Fig. 12 below). The site comprises a complex of rockshelters and small cliffs, over which loess deposits of variable thickness have been deposited. In situ flint nodules are exposed within the bedrock limestone. Past fluvial activity, and human excavation, has exposed a number of rockshelters, many of which are still used for sheltering animals and which may have been used for religious purposes in historical times. Consequently the exposed rockshelters themselves no longer contain any sediment of Pleistocene age, although one rockshelter on the northern edge of the complex is still partially buried by loess. The latter, as well as the small cliffs and slopes above the rockshelter complex, was of most interest in this study.

Dealul Peşterica was initially reported as a site by N. Zaharia in 1956, and A. Păunescu collected pieces from the surface in 1971–1973, 1977–1979, 1981–1983 and 1993 (Nicolăescu-Plopşor et al., 1959; Păunescu et al., 1972; Păunescu, 1999: 178–182). The lithic assemblage from Dealul Peşterica was analyzed by Doboş (2010), and comprises 187 pieces, of which 70 are tools. The highest proportion of retouched tools is made up by simple scrapers. Levallois technology is barely present (IL = 3%, ILty = 7.1).

In 2012, surface survey was undertaken of the hillside and remaining loess slope blanketing the northernmost rockshelter. Following initial survey, a profile was cleaned in the loess was cleaned, and four testpits were excavated in a transect along the slope, to investigate the stratigraphic context for the surface lithics and to identify the likely archaeological level. Small quantities of in situ lithics were found in each of the testpits, suggesting that the surface material does have a stratified origin. Luminescence dating samples were collected and are currently being processed. The juxtaposition of both rockshelter and open air sites with extensive raw material sources across the Peştera valley makes this region one of the most prospective for future exploration. The proximity of the flint sources facilitates more detailed examination of the interplay between technological tradition and economic practices through time (Fig. 13).

4.2.4. Gherghina

A large collection of lithic artifacts attributed to the Gravettian ($n = 1034$) was amassed by Al. Păunescu and M. Eugen from 1982 to 1985 on the surface near the old quarry at Gherghina (Păunescu, 1999: 121, also Fig. 33). However, no in situ layer was found. As Gherghina lies very close (a few hundred meters) to one of the best-

Table 1
Luminescence dating supporting data and age estimates for the Cuza Vodă site, southeastern Romania.

Sample code	Depth (m)	De (Gy)[a]	σ (%)	Unattenuated dose rates (Gy/ka)			Total dose rate (Gy/ka)[e]	Age (ka)
				β[b]	γ[c]	Cosmic[d]		
EVA1043	0.7 ± 0.1	175 ± 4	7	1.63 ± 0.16	0.88 ± 0.09	0.19 ± 0.02	3.2 ± 0.5	54.7 ± 7.0
EVA1044a	1.0 ± 0.1	263 ± 5	8	1.40 ± 0.14	0.75 ± 0.08	0.19 ± 0.02	2.8 ± 0.4	94.7 ± 13.9
EVA1044b	1.0 ± 0.1	337 ± 19		1.40 ± 0.14	0.75 ± 0.08	0.19 ± 0.02	2.8 ± 0.4	121 ± 19

[a] Determined using the Central Age Model (CAM) of Galbraith et al. (1999).
[b] Measured using beta counting.
[c] Measured using high resolution germanium gamma spectrometry at the Felsenkeller, Dresden, Germany.
[d] Calculated based on Prescott and Hutton (1994).
[e] Corrected for attenuation. Water content was measured at 6 ± 3%. An α-value of 0.1 was used.

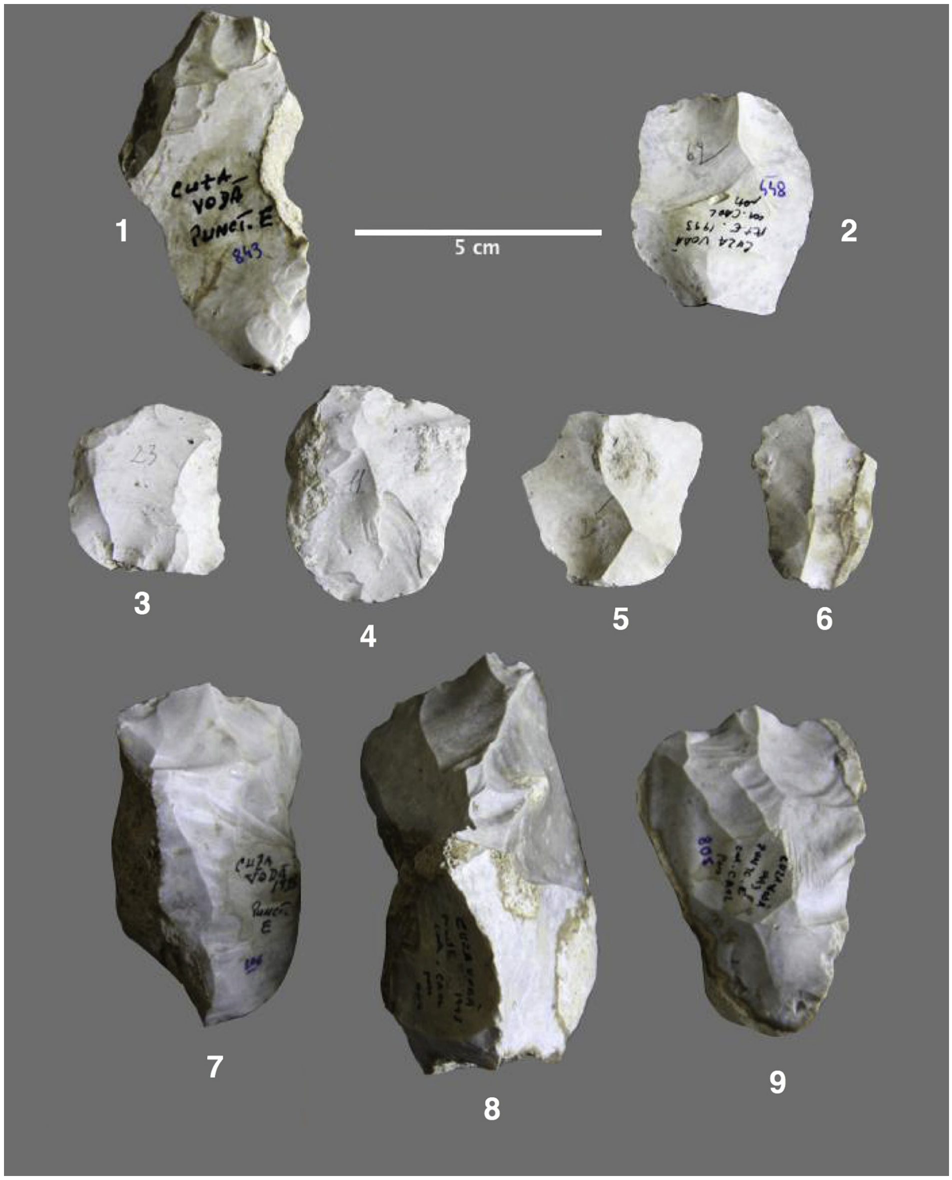

Fig. 10. Selected artifacts from previous surface collections at Cuza Vodă. 1–2: truncated-facetted pieces; 3–6: possible Levallois products; 7–9: cores.

studied loess profiles in the region (Mircea Vodă, Buggle et al., 2009), if in situ lithics were found then the paleoenvironmental context could be well constrained. This formed the rationale for revisiting this site.

The LoDanS team visited Gherghina in 2012 but was unable to find either surface or in-situ lithics. The stratigraphic trench made by Păunescu could likewise not be located, suggesting that it was most likely destroyed by erosion. Nevertheless, the presence of microlithic surface material elsewhere in the Ţibrin Valley (Păunescu, 1999) indicates the potential for further archaeological survey in the region.

4.2.5. *Ţibrinu*

The Ţibrin valley, and especially Lake Ţibrinu, was described by Păunescu as a region containing numerous Paleolithic and younger sites (Păunescu, 1999). These included a perforated cave bear canine and a bone with geometric markings (Păunescu, 1999, Fig. 3), assigned to the Gravettian over an area of approximately 20 m^2, as well as an excavation trench containing several hearth features.

The LoDanS team surveyed the southern side of the lake in 2012. Unfortunately, although we found a single lithic artifact close to the southern shoreline of the lake, we failed to relocate the exact locations of Păunescu's sites. Abundant vegetation and a high water level made it difficult to access the profiles, as well as the lack of obvious topographic landmarks on the available photos, may account for this result.

4.2.6. *Ghindăreşti*

The Ghindăreşti site is located on the Danube River in the northernmost part of the study area. It comprises a substantial loess profile containing a number of loess–paleosol complexes, with collapse of parts of the uppermost portion of the profile obscuring portions of the section (Fig. 13). Ghindăreşti was previously described as a Paleolithic site by Păunescu (1999: 126). The profile contains thick paleosol horizons containing pachyderm tusks. Lithics were collected from the base of the profile.

The LoDanS team revisited the site in 2010 with the view to locate the stratigraphic layer from which the surface-collected

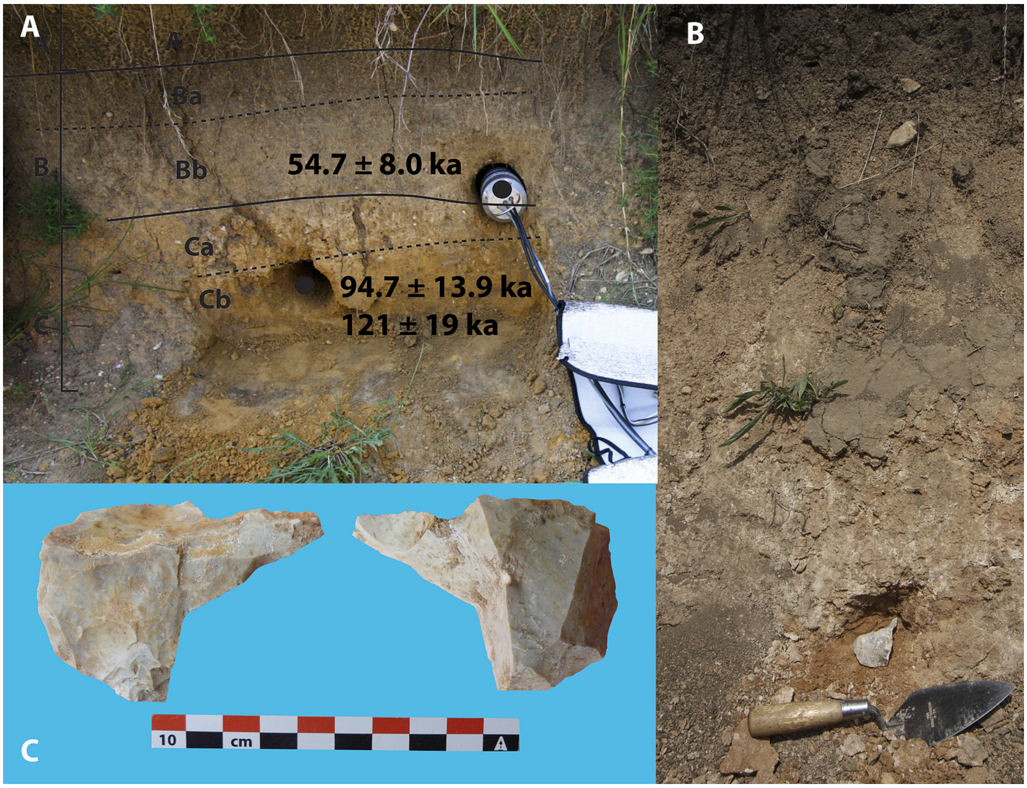

Fig. 11. (A) Chronostratigraphy of the Cuza Vodă site, including luminescence ages. (B) Location of the in situ artifact. (C) In situ artifact after washing.

lithics originated. However, the catastrophic collapse of the uppermost portion of the loess profile cast doubt on the antiquity of the surface lithics collected by Păunescu at the base of the slope. The uppermost part of the profile contains a large Neolithic site, indicating redeposition of this Neolithic layer down the slope during its collapse. The rather undiagnostic lithic material was found to co-occur with Neolithic pottery, suggesting that the material collected at the site was more likely to be Neolithic than Paleolithic (Fig. 13). However, the pachyderm remains may be of interest for palaeontological study.

4.2.7. Saligny-Făclia

The site at Saligny-Făclia is located to the west of the village with the same name, on the slope of the Azizia hill. The first lithics were

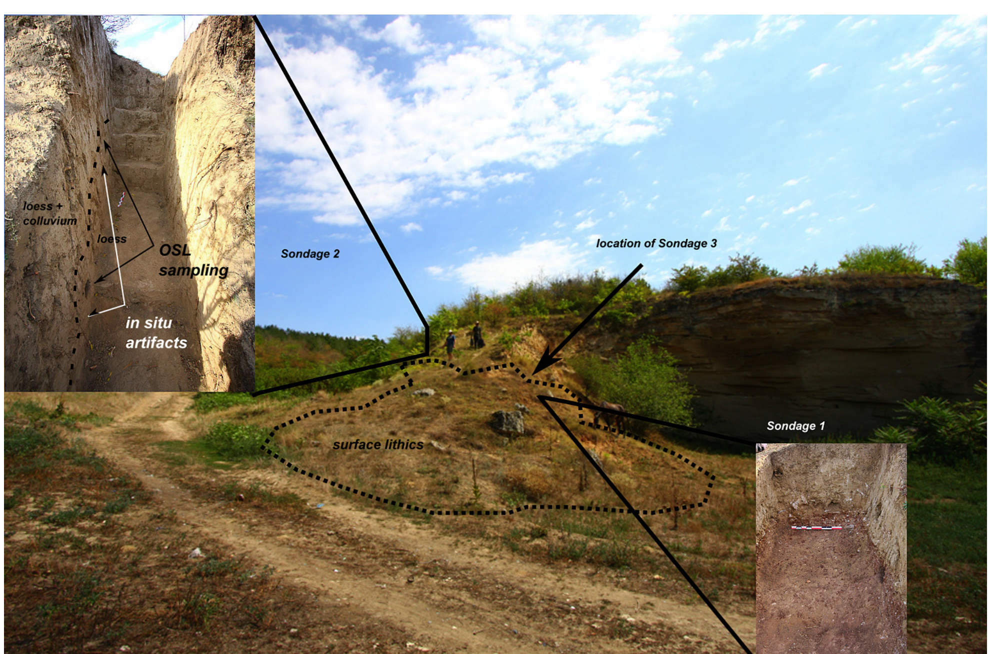

Fig. 12. View from the southwest looking at the Dealul Peşterica site. Inserts show two of the sondages which yielded artifacts.

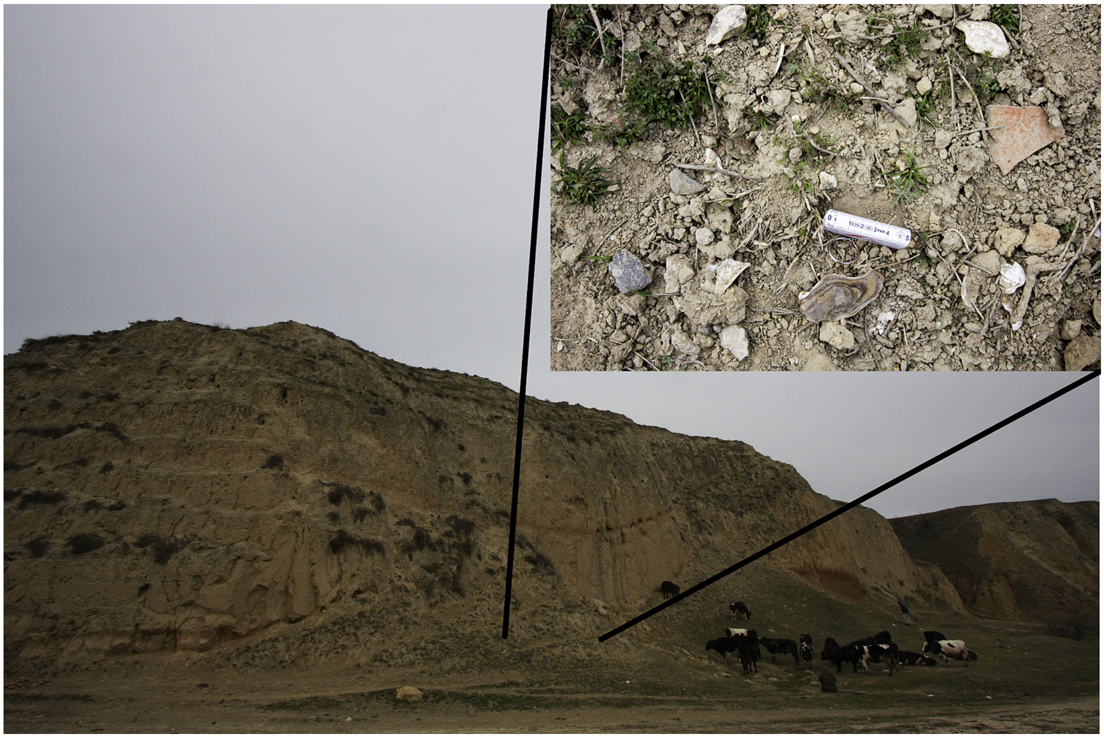

Fig. 13. The collapsed profile at Ghindăreşti. Insert illustrates the presence of stone tools and pottery redeposited at the base of the section.

identified by N. Zaharia in 1956. Păunescu also collected lithics on the surface during field surveys undertaken in the 1970s and 1980s. The lithic series studied by Doboş (2010) comprised 189 pieces, of which 64 were tools. Most numerous tools are notches and denticulates, and Levallois indices are fairly low (IL = 6.4, ILty = 12.5). Păunescu also described four bifacial pieces, of which only one fragment of a foliate biface could be found in storage at the Institute of Archaeology. The importance of bifacial foliates, as one of the few formal tool types in the local Paleolithic was also considered in a regional context, where such points occur in both late Middle Paleolithic and 'Transitional' industries (e.g., Sirakova and Ivanova, 1988).

Păunescu interpreted these pieces to have come from a red-yellowish sediment, most likely a 0.1–0.3 m thick paleosol (Păunescu et al., 1972; Păunescu, 1999: 186–191). Since this description suggested potential for a dateable open air loess site, we decided to revisit the area described and illustrated by Păunescu. Unfortunately, neither artifacts nor traces of the old trench were found at all. Subsequent road construction may have completely destroyed or buried the site.

5. Discussion and conclusions

Our field research in the Lower Danube steppe has identified a number of sites which indicate hominin occupation of the region at least by MIS 11 and throughout the Paleolithic. The LoDanS project thereby has begun to contribute useful data relating to hominin occupation and dispersal in this geographically important, but previously understudied region.

We discovered and documented, for the first time, the Middle Pleistocene settlement of the region, at least by the MIS 11 interglacial, at the site of Dealul Guran (Iovita et al., 2012). Despite several known Middle Pleistocene-age sites of comparable age or older in Western Europe, the center and east of the continent contain relatively few sites. The most likely reason for this paucity of sites is the widespread loess deposits across Eastern Europe, which indicate that sites of Lower Paleolithic antiquity are most likely deeply buried and therefore difficult to find. Certainly, there are even fewer sites older than MIS 11 in the region. This is despite the fact that the loess steppe of the Lower Danube basin was relatively climatically stable and never experienced glaciation, resulting in a generally stable potential refugium during glacial periods (Fitzsimmons et al., 2012).

The region was also occupied during the Middle and Upper Paleolithic phases of the Late Pleistocene, as demonstrated by new luminescence dating of the Cuza Vodă assemblage, and luminescence dating of the upper layer at Dealul Guran (Iovita et al., 2012). Unfortunately, however, these studies as yet can only argue for hominin occupation during these periods, and more detailed subsistence or behavioral strategies cannot as yet be elucidated, higher resolution data being needed to warrant further speculation. The proximity of both Cuza Vodă and Dealul Guran to raw material sources, and the present lack of longer stratigraphic sequences, make it difficult to interpret the stone tool technology based on a techno-typological characterization at this stage. Further survey and excavations are needed to piece together a more complete framework from which interregional comparisons can be made in order to investigate dispersal routes and rates. Sites with better organic preservation are needed for a more nuanced view of land-use strategies, and especially for evaluating the role of ecological niches in human colonization events. Although organic preservation is often said to be bad in the loess steppe, the presence of abundant animal bones in the profiles at Urluia, Lipniţa, and Ghindăreşti give hope that sites preserving organic materials will be discovered in the future.

The greatest challenge facing further discovery of Paleolithic sites in the lower Danube region remains the problem of loess cover and deep burial. Loess deposits can be up to 30–40 m thick in some areas (e.g., Buggle et al., 2009; Vasiliniuc et al., 2011; Fitzsimmons et al., 2012), and although these archives provide valuable paleoenvironmental contexts for archaeological studies, they make equally difficult archaeological prospection which must first be undertaken close to the surface. The strategy developed in our study aims to overcome this challenge by focusing on areas where the loess cover is thinnest, associated with caves and rockshelters which represent promising habitation sites within this landscape. Of the rockshelters identified, the most prospective ones are often those where roof collapse has preserved archaeologically-rich sediments. This situation is similar to that of Crimea, where the underlying limestone bedrock is, by contrast, more conducive to the formation of rockshelters to begin with. In Dobrogea, karst features are often completely buried under loess and their structure is not easy to map out without the aid of geophysical techniques. Moreover, small testpits can often encounter zones of roof fall which prevent further excavation. To a certain extent, the problem of deeply buried sites may be helped by hand-coring, which has led to higher discovery probabilities elsewhere (Verhagen et al., 2013) and overcomes the limitations imposed by limited size test excavations. This technique is perhaps better suited for use in open-air situations comprising easily cored loess sediments, and our own project aims to incorporate a systematic coring program in future surveys. In general, it is clear that a combination of foot survey, coring, and geophysical techniques, targeted through systematic strategies based on geological and geomorphological context, will provide the greatest chance of success for archaeological survey in the loess steppe.

Independently of the development of systematic surveying strategy and methods, however, our expectations of site character and density must also adapt to the local conditions. Unlike the classic West European Paleolithic, the Eastern European loess belt is characterized by open landscapes and high sedimentation rates that are likely to provide a different type of archaeological site. Occupation in the steppe is likely to be much more widespread and the traces more ephemeral, leading to generally low site densities, as well as lower artifact densities in local concentrations (sites). Caution should be taken, particularly by those more accustomed to Western European archaeological contexts, to reduce the tendency to interpret this landscape as generally empty, with sparsely distributed lithics. Systematic surveys in low-density open air situations where sediment accumulation is negligible, such as desert pavements (Chiotti et al., 2009; Olszewski et al., 2010) can give an insight into what might underlie the loess cover in our study region, and how rich the archaeological record is likely to be. For this reason, it is important not to draw premature conclusions about population densities and occupation intensity from low site and artifact densities. It is recommended to undertake systematic surveys of the same area at regular intervals, taking advantage of present-day erosion to observe patterns in the presence and absence of finds (e.g., Stern et al., 2013). Such a long-term approach will enable the use of site discovery data in predictive models that can be used to enhance future fieldwork.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.quaint.2013.05.018.

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