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Three climatic cycles recorded in a loess-palaeosol sequence at Semlac (Romania) – Implications for dust accumulation in south-eastern Europe

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ABSTRACT

Recent investigations of the Semlac loess section in the south-eastern Carpathian Basin, which is situated at an undercut slope position on the right bank of the Mureş River in its lower reaches (Banat region, western Romanian), are presented and discussed. Dating back to marine isotope stage (MIS) 10, the more than 10 m thick loess sequence includes four fossil soil-complexes developed in homogenous and relatively fine silty loess. Because of the good preservation of the sediment, Semlac is regarded as a key section for the Carpathian Basin, which offers possibilities to a) improve the understanding of the type and composition (loess homogeneity and pedogenic alteration) of the lowland loess sequences in the Carpathian Basin also beyond the last interglacial palaoesol complex, b) to reconstruct the temporal evolution of the local loess-palaoesol successions, c) gain better insight into the regional paleoenvironments of the last 300 ka and d) to compare the loess of the region to loess-sequences in adjacent areas and to dust proxy data in the northern hemisphere.

An integrated age model based on correlation to reference records and luminescence dating is compiled. Applying this age model we compare climate proxy data from Semlac to both global data and to data from the very southeast of the Carpathian Basin (Vojvodina, Serbia).

The obtained results provide new insight into the dust accumulation regime for the eastern Carpathian Basin and offer new palaeoenvironmental information for the region and are an important step towards establishing a catena from the thin loess-like sediments of the Banat foothills in the East towards the thicker and seemingly more complete loess sections of the south-eastern and central Carpathian Basin. Disentangling grain size data from soil formation proxies is used to investigate patterns of non-local dust. Patterns of non-pedogenetic fine material are similar to grain size proxies from China and other parts of the northern hemisphere, suggesting western and eastern Eurasian loess to have (at least partly) similar mechanistic/climatic origins.

1. Introduction

Loess sections in and around the Carpathian Basin are important archives for the reconstruction of the palaeoenvironmental changes and the evolution of human cultures during the Pleistocene (e.g. Iovița et al., 2014; Marković et al., 2015; Neugebauer-Maresch et al., 2014). Whereas numerous sections from the southern and western part of the basin have been investigated (Antoine et al., 2009; Frechen et al., 1997; Fuchs et al., 2008; Horváth, 2001; Lukić et al., 2014; Marković et al., 2015, 2014, 2011, 2009, 2004; Obreht et al., 2014; Rolf et al., 2014; Sümegi, 2005; Újvári et al., 2014b) the loess cover of the plain west of the Carpathian Mountains (Western Romanian Banat), remained relatively unexplored. Here only a few sections have been studied (Semlac,

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Românești, Coșava, Vinga, Stamora-Moravița and Zabrani; (Conea, 1970; Conea et al., 1972; Florea et al., 1966; Kels et al., 2014; Mogoșanu and Cârciumaru, 1978; Schulte et al., 2014; Sitlivy et al., 2014, 2012; Tuffreau et al., 2007). Some of these contain important records of Upper Palaeolithic cultural remains proving that the region is a key area for the reconstruction of human cultural evolution during and after the arrival of anatomical modern humans (AMH) to Europe (Anghelinu et al., 2012; Anghelinu and Niță, 2014). The Semlac section in the north-west of the Village Semlac (Romanian Banat) is the most extensive well exposed loess sequence, having the potential to serve as key section for the south-eastern border of the Carpathian Basin. The area has been studied before (Florea et al., 1966), but this study aims to re-evaluate the stratigraphy with contemporary methods by combining detailed lithologic/pedologic logging, granulometry, environmental magnetism and luminescence dating.

Age models of loess-palaeosol sequences can be based on a combination of radiometric and dosimetric dating (^{14}C, luminescence; Antoine et al., 2009; Constantin et al., 2014; Feurdean et al., 2014; Frechen et al., 1997; Fuchs et al., 2008; Stevens et al., 2011; Újvári et al., 2014a) of the last climatic cycle, and a correlative approach of the older sediments, where correlation to different target curves has been suggested (Basarin et al., 2014; Buggle et al., 2009; Marković et al., 2012a; Necula et al., 2013, 2015a, 2015b and references therein).

Palaeoenvironmental information is often inferred from environmental magnetic, geochemical, colour and grain size properties of the sediment having undergone more or less strong soil formation. It is generally accepted that loess-palaeosol sequences in the Carpathian Basin followed global climate trends with relatively warm and humid interglacials and interstadials and relatively cold and dry glacials and stadials (Basarin et al., 2014; Buggle et al., 2009; Marković et al., 2012a), and represent major European Middle and Late Pleistocene terrestrial records. Further, studies of fossil faunas (especially molluscs, Marković et al., 2007, 2006; Sümegi et al., 2015; Sümegi and Krolopp, 2002), charcoal (Rudner and Sümegi, 2001; Willis and van Andel, 2004) and molecular fossils (Buggle et al., 2010; Buggle and Zech, 2015; Zech et al., 2012, 2013) preserved in loess-palaeosol sequences are discussed and used to gain insight into palaeoenvironmental conditions during the Pleistocene in the Carpathian Basin.

By means of grain size analyses we present new data and insight into the loess characteristics of the Western Plain of Romania. Most impressive is the fact that stratigraphic patterns are different from isochronous deposits from the central and south-central Carpathian Basin (Serbia and Hungary; see e.g. Basarin et al., 2014; Buggle et al., 2009; Marković et al., 2012a, 2012b; Újvári et al., 2014a, 2014b), which is ascribed to a higher proportion of non-local dust and also different local climate and geomorphologic conditions.

2. Regional setting and previous investigations

The section is located in the Arad Plain (Câmpia Aradului) in the Western Plain of Romania, west of the Carpathian Mountains. In this region the cover of loessic material is partially exposed on the northern bank of the Mureș River due to undercut slopes. The thickest and most accessible known natural loess outcrops can be found near the village Semlac (Fig. 1).

The recent climatic conditions from Timişoara, about 50 km to the southeast, show a mean annual air temperature of 10.9 °C and an annual mean precipitation of 631 mm (for the years 1896–1955). The temperatures in July are 21.5 and −1.5 in January (Badescu and Zamfir, 1999).

Former investigations (Florea et al., 1966) ca. 5 km south-west of Semlac showed three “soil-subjacent deposit alterations” in a 20 m thick section which is not exposed anymore. At that time, no numerical dating was applied. Therefore, the authors used morphological, granulometric and palynological data to assign the loess-like sediments and fossil soils of the uppermost 15.80 m to the Würmian (Last Glacial) and reconstructed variations of climatic conditions. As this former section does not exist anymore we surveyed the steep Mureș river banks close to the village in 2010, and a new and deeper sequence was excavated at the north-eastern entrance of the village (46° 7′12.97″N/20°56′54.70″E/~100 m a.s.l.). The whole section can be subdivided into four individual palaeosol complexes and the recent soil, a slightly eroded chernozem. The Semlac composite profile consists of six subprofiles, shown in Appended Fig. A.1.

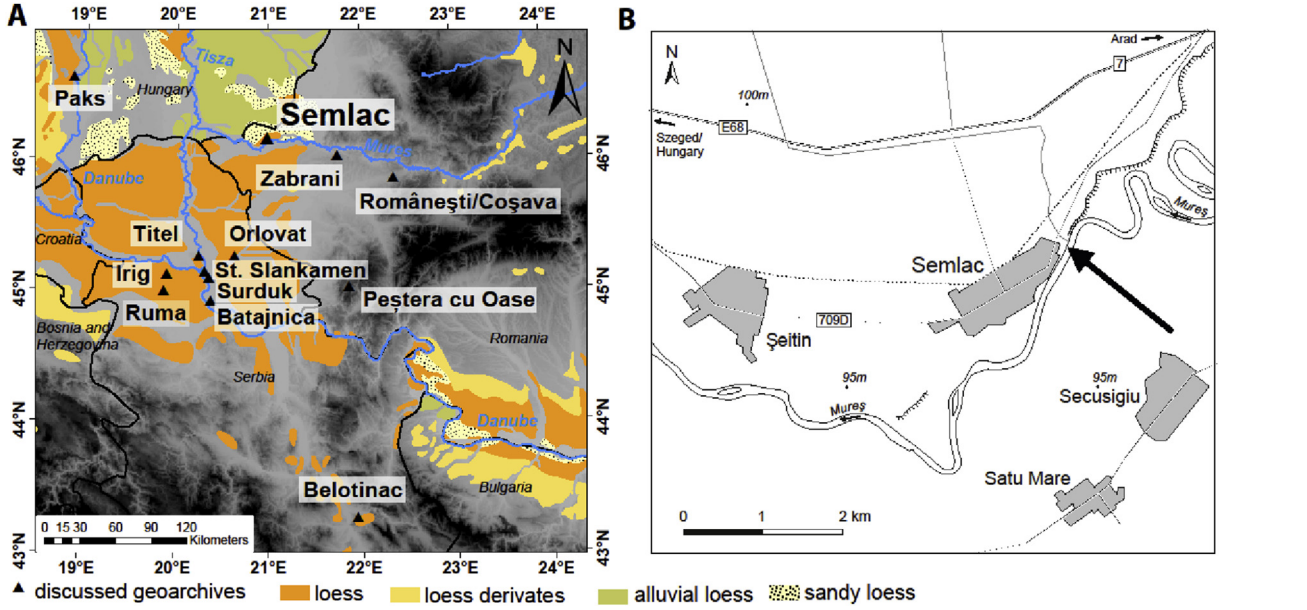

Fig. 1. A) Loess distribution in the eastern Carpathian Basin (modified according to Haase et al., 2007) with most geoarchives mentioned in this study. Stari Slankamen abbreviated as St. Slankamen B) Location of the section (arrow) east of the village Semlac at the north-western bank of the Mureș River.