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Sedimentary characteristics and source of loess in Baranja (Eastern Croatia)

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ABSTRACT

Loess is a type of terrestrial clastic sediment formed by the accumulation of wind-blown dust, composed dominantly of silt-sized particles. It is usually inter-bedded with soil horizons forming loess–palaeosol successions (LPS). The thickest LPS in Croatia are found in Baranja, a region bounded by two large rivers, the Danube and the Drava. The results of grain-size and modal analysis provide information about source material and wind direction in different time periods during the Pleistocene. Grain-size distribution is in good accordance with other loess localities in the Pannonian Basin. Garnet, epidote and amphibole are the most abundant heavy minerals in samples of Danube river sediment. The comparison of heavy mineral assemblages (HMF) from LPS with that of the Danube river, shows that the main source area for loess in Baranja was in the Danube flood plain sediments. Main transport direction was from North or Northwest. Nevertheless the higher concentration of amphiboles in LPS (mean 26.3% in HMF) than in the Danube plain suggests an additional source area. Although the Western Carpathians with Neogene calc-alkaline volcanic rocks are the major source for amphiboles in the Pannonian Basin, those minerals may partly originated also from locally exposed volcanic and metamorphic rocks of the southward Slavonian Mountains. Mount Krndija and Mount Papuk, which of all Slavonian Mts. are closest to Baranja, consist indeed of amphibolites. In that case, a small amount of silt material for Baranja loess would be transported by WSW winds. Results obtained from sedimentological and SEM analyses show fairly good congruence with results from other LPS in the Pannonian Basin, with some differences in mineral composition which imply diversity and shifting of source area for Baranja loess during the Late Pleistocene.

1. Introduction

Quaternary sediments are widespread in Croatia. They cover about 35.7% of the Croatian territory (Bognar, 1976). Baranja, a region in Eastern Croatia (Fig. 1) and in southern margin of Pannonian Basin is almost completely covered with Quaternary sediments (Pikija and Šikić, 1991). Regarding their origin, loess and its derivatives occupy a special place within these sediments. Loess is a terrestrial clastic sediment, but it is not just accumulation of airborne dust (Pécsi, 1990). It covers vast areas in Central, Eastern and Southeastern Europe (Haase et al., 2007). Loess is inter-bedded with soil horizons forming loess–palaeosol successions (LPS). Due to that characteristic LPS are excellent records of palaeoclimate and environmental changes in the Pannonian Basin for last 1 Myr (Marković et al., 2011). Palaeoclimate changes during the Pleistocene were the forcing mechanism that induced silt-sized particles production, which determined wind direction that again controlled the geographic distribution and thickness of loess and therefore its characteristics (Wright, 1995; Smalley et al., 2005). During the Pleniglacial in SE Europe palaeoclimate was more humid in older periods with an increase of palaeoprecipitation from younger to older periods (Bokhorst et al., 2009; Buggle et al., 2009, 2011).

One of the most specific characteristics of loess is its grain size distribution. Most authors (Bognar, 1976; Nemecz et al., 2000; Pécsi, 1990; Smalley, 1966; Smalley et al., 2005; Wright, 1995, 2001) agree that typical loess has a grain size distribution in the silt range, 20–60 μm. The origin of those silt particles and their transport mechanism is the main question in over one century of loess research. Two main opposing hypotheses, endogenetic and aeolian, describe the formation of thick loess deposits. The first emphasizes diagenetic processes in silty material as being crucial in loess formation, while the second favors aeolian transport of silt-size particles. The aim of this study is to determine source area for loess in Baranja together with dominant wind direction during the

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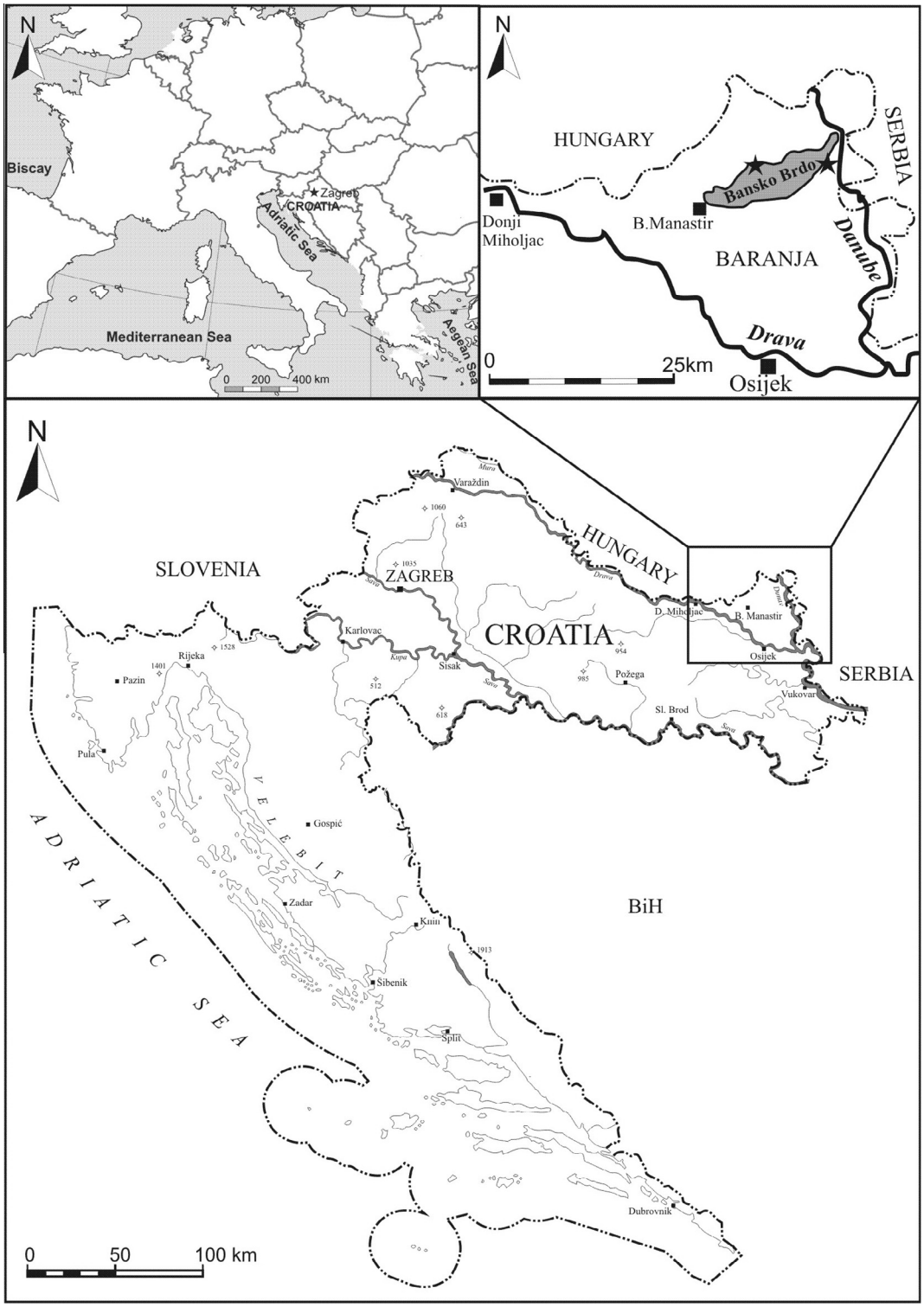

Fig. 1. Map showing the position of Croatia, Baranja and two investigated loess profiles at slopes Bansko brdo hill.

Pleniglacial by identifying mineral composition of the heavy mineral fraction and the morphology of quartz grains. For this purpose two loess profiles at Bansko Brdo hill were selected and bulk loess samples were collected. Geochemical and mineralogical bulk loess sediment analyses along parts of the Danube in NE and E Romania have pointed out that the main sediment for loess deposits was transported by winds from a NNW/NNE direction, indicating forcing by northerly winds from the Fennoscandian ice sheet (Buggle et al., 2008). There are certain limitations of this approach because Pleistocene loess deposits must have been at least partially recycled and well homogenized during fluvial and subsequent aeolian transport processes. Hence, a precise determination of provenance areas based on whole-rock geochemistry cannot be made (Újvári et al., 2008). Studies indicate that the majority of Southeastern European loess derives from Danubian alluvium, ultimately sourced from glacial grinding and reworking of Alpine and Moravian as well as Carpathian rocks (Buggle et al., 2008). Bokhorst et al. (2011) suggest a domination of western winds during the