Towards multi-proxy based millennial time scales in Late Pleistocene Danubian Loess-Palaeosol Sequences

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Late Pleistocene palaeoclimatic records for south-eastern Europe rely largely on loess-palaeosol sequences (LPSS). The general spatial scarcity and often limited temporal range of other sedimentary archives assign the LPSS of the region a key role even in millennial scale temporal reconstructions of the Late Pleistocene terrestrial environmental dynamics. In Eurasia, aeolian dust sediments (loess) are widespread in continental mid-latitudes. The Eurasian loess-belt has its western end in the Middle Danube (Carpathian) and the Lower Danube Basin. Similar to the Chinese Loess Plateau (CLP) and to the steppe areas of Central Asia one can find true loess plateaus in this area dating back more than one million years and comprising a semi-continuous record of the Quaternary palaeoclimate (Marković et al. 2011, 2015).

Loess forms from aeolian dust and consists predominantly of common silicates and a varying amount of detrital carbonate; it reflects the average geochemical composition of the upper continental crust (cf. Muhs 2013). After deposition the aeolian silt undergoes a special diagenetic process called "loessification" which comprises initial silicate weathering, partial carbonate dissolution and re-precipitation as well as the neo-formation of clay minerals. It also controls the complex geochemical dynamic of Iron (Fe) which in turn is responsible for the colour and magnetic properties of the loess. No sharp limit can be drawn between "loessification" and soil formation as long as the detrital carbonate is not completely dissolved and subsequently intense silicate weathering starts. When more humid conditions predominate, synsedimentary pedogenesis prevails and (embryonic) soil horizons are formed which are rapidly buried by fresh dust as soon as the climate returns to drier conditions. These buried soil horizons are referred to as palaeosols and developed during the humid and warm interglacial phases of the Pleistocene as mature soils, when aeolian silt deposition – as generally assumed – dramatically decreased or even ceased in most parts of western Eurasia. Loess deposits with intercalated palaeosols represent the most widespread terrestrial archives of Quaternary climatic fluctuations in Eurasia (Hosek et al. 2015, Marković et al. 2015).

The LPSS of the Lower Danube and the Carpathian Basin allow inter-regional and trans-regional correlation and, even more importantly, the analysis of temporal and spatial trends in Pleistocene palaeoclimate, even on hemispheric scales (Buggle et al. 2013; Marković et al. 2015). However, the general temporal resolution of the LPSS seems mostly limited to (sub)deca-millennial (orbital) scales enabling the correlation of their well documented

palaeoclimate record to the marine isotope stages (MIS) and thus to the course of the global or northern hemisphere ice volume with time (cf. Basarin et al. 2014).

Magnetic susceptibility (χ, χ_{fd}) and grain size (GS) became fundamental palaeoclimate proxies in loess research. They are highly sensitive proxies for the environmental conditions during loess accumulation (cf. Buggle et al. 2014; Muhs 2013). χ reflects the neo-formation of magnetic minerals in the course of silicate weathering and depends largely on the temporal variation of soil humidity and thus the temporal course of palaeoclimate, given that the parent dust from which the loess was formed is mineralogically homogenous. GS, however, reflects the aeolian conditions during dust transport and deposition as well as post-depositional processes like pedogenesis. Recent studies on GS trends across the CLP reveal Late Pleistocene palaeoclimatic fluctuations on millennial scale which correlate to the Dansgaard-Oeschger (D-O) events known from the Greenland Ice Cores (GIC) (Yang & Ding 2014). Such millennial scale variations were up to date not observed in Late Pleistocene Danubian LPSS.

In order to investigate the potential of Danubian loess in recording millennial palaeoclimate variability, Late Pleistocene LPSS from the southern Carpathian Basin (Titel-Plateau) and the eastern Lower Danube Basin (Dobrogea) were sampled in high resolution (5 to 2 cm spacing). A chronological frame is provided by luminescence dating, tephra-chronology and the correlation of palaeoclimatic proxy parameters to marine and ice core records. Here, we focus on the environmental records of the past 60 kyrs, an interval of extreme palaeoclimatic dynamics during which anatomically modern humans dispersed into Central and Western Europe.

The down-section temporal variability of χ, χfd and GS as palaeoclimatic proxy parameters reveals detailed information on the environmental dynamics. Based on these records we can draw the following conclusions:

- Estimated accumulation rates in both regions are relatively homogeneous over the past 60 kyrs.
- In the studied sections, millennial scale variations are present probably reflecting Dansgaard-Oeschger (D-O) cyclicity.

There are a lot of similarities between the environmental records of the Vojvodina and the Dobrogea and also between these records and those from the Chinese Loess Plateau, but also fundamental differences.

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