



## Geomagnetic excursions recorded in loess: case studies from the Danubian loess province

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Geomagnetic excursions are prominent short-lived features (normally < 5 kyr) of the Earth's magnetic field and lie temporally between Microchrons (Laj & Channell 2007) and short time intervals of anomalously high secular variation. Because of their short duration and the time required for remanence acquisition in sediments their record in terrestrial archives is scarce. However, already in the seventies (Tucholka 1977) and increasingly since the nineties of the last century (e.g. Zhu et al. 1994), geomagnetic excursions were reported even from loess deposits.

Loess is defined as aeolian transported silt which underwent a special diagenetic process called "loessification" after deposition (Pécsi 1990, Smalley et al. 2009). "Loessification" comprises 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. Because all these processes are typical for pedogenesis, "loessification" can be regarded as an extremely weak soil-forming process. Loess is by far the most important terrestrial archive that provides detailed palaeoclimatic information for the whole Quaternary and in China goes back to even the Pliocene. Though sedimentation rates may differ with climatic conditions, loess-palaeosol sequences may represent high resolution geoarchives of past environmental conditions.

The success story of magnetic polarity dating in terrestrial Quaternary sequences started with the seminal work of Friedrich Heller and Tung-Sheng Liu assigning the Chinese loess to the Quaternary time table and correlating it with the global ice volume record (Heller and Liu 1982, 1984). Though it was thought to be unlikely that short polarity excursions have been recorded in Chinese loess, evidence even for Matuyama age excursions from the Baoji loess section in southern China were reported recently by Yang et al. (2004, 2007). Moreover, Pilipenko et al. (2006) and Zhu et al. (2006) presented records containing excursions directions from last glacial loess sections in the Ukraine and the Chinese loess plateau.

Here we report on recent results from high-resolution palaeomagnetic studies from the Middle Danube basin. The lower part of the loess section at Stari Slankamen (Vojvodina, Serbia) can be assigned to the late Matuyama and early Brunhes Chrons. Though the directional record is ambiguous in some intervals where strong pedogenesis caused secondary magnetisations, evidences for late Matuyama (Kamikatsura, Santa Rossa) and early Brunhes (ST 17) excursions could be found in the directional as well as in the relative palaeointensity record. At Süttö (North Hungary), Krems and Willendorf (Lower Austria) we sampled last glacial loess. Independent age control is provided by the correlation of environmental magnetic data to Greenland ice core records, by luminescence and radiocarbon dating (Austrian sites). Due to high sedimentation rates (10-50 cm/kyr) and quasi-continuous sampling we found combined evidence by directional and relative palaeointensity records for the Laschamp and Mono Lake excursions. The record of excursions directions, however, seems directly related to sedimentation rates. Even though in some intervals excursions directions are recorded, the amplitudes seem to be attenuated. Nevertheless, the records of geomagnetic excursions from these loess sites provide precise chronostratigraphic information and valuable data for the reconstruction of the past geomagnetic field.

The presented high-resolution palaeomagnetic records clearly emphasise the yet largely undiscovered but high potential of quasi-continuously deposited loess containing archaeological remains for palaeomagnetic studies. Furthermore, the use of geomagnetic excursions as time markers in the Brunhes and Matuyama Chron age loess sequences opens a new perspective for dating of loess sites which are hardly datable by other methods.