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Effects of dust source change, weathering and pedogenesis on loess sediments revealed by combined magnetic and geochemical studies – opportunities and challenges

Diana Jordanova and Neli Jordanova
National Institute of Geophysics, Geodesy and Geography - Bulgarian Academy of Sciences, Sofia, Bulgaria
(diana_jordanova77@abv.bg)

Loess paleosol sequences carry valuable information on global climate change during the Quaternary. The main geochemical paleoenvironmental proxies rely on the well established sequence of mineral weathering and its products under earth surface conditions. On the other hand, mineral magnetic signal of the loess – paleosol sequences represent easily measurable and sensitive tool for identification and semi-quantification of the degree of secondary alterations of the initial loess substrate. We have analyzed geochemical and magnetic properties of a collection of loess – paleosol sediments from North Bulgaria from 8 profiles, spanning the time interval of the last 800 kyrs. Weathering indices calculated from the bulk geochemical data on major oxides indicate that loess samples are characterized by wide range of Chemical Index of Alteration (CIA) values – from 57.8 to 83.5 with the highest values typically obtained in the oldest deposits, formed during marine oxygen isotope stages (MIS) 16 and 18. On the other hand, CIA values for paleosols are restricted in the range 73.4 – 82, indicating an intermediate weathering degree. Classic ternary A-CN-K diagram implies dominant role of plagioclase weathering. Magnetic signature of the studied collection shows typical widely observed magnetic enhancement in paleosols as compared to weakly magnetic non weathered loess material. The content of ultra fine grained superparamagnetic magnetite/maghemite give rise to the percent frequency dependent magnetic susceptibility, which shows linear relationship with CIA values, proving the genetic linkage between weathering and pedogenic magnetic fraction. On the other hand, calculated background magnetic susceptibilities χ_{bg} for the loess-paleosol couplets included in the study show reverse linear relationship with CIA values for the loess samples. Searching for possible effect of changing dust source areas, we observe decreasing χ_{bg} for sites located progressively eastward (longitudes varying from 23^{o}E to 29^{o}E) along with linear increase of χ_{bg} with increasing Cr/V ratio, indicative for increasing contribution of mafic component. At the same time, samples from loess horizons with the lowest χ_{bg} are characterized by the highest Al_2O_3/SiO_2 values, e.g clay content. Thus, decreasing χ_{bg} along W – E transect probably reflects combined effects of dust source change and grain size fining during aeolian dust transportation. The relationships between CIA, χ_{bg} and pedogenic magnetic signatures suggest that aeolian dust material was already weathered before its deposition. As a result, the following periods of paleosol formation during interglacial epochs occurred under supply – limited weathering regimes.

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