Clay mineralogy of the Stari Slankamen (Serbia) loess-paleosol sequence during the last glacial cycle — Implications for dust provenance and interglacial climate


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1. Introduction

- Clay minerals in loess-paleosol sequences carry important information on dust source and the paleoenvironments of the areas of loess distribution.
- The loess-paleosol sequences in the Serbian part of the Carpathian Basin are among the most complete Quaternary terrestrial sedimentary sequences in Europe. However, relatively little is known about the origin and temporal variations of clay minerals in these deposits and their paleoclimatic implications.
- Here we present the first clay mineral record from Serbian/European loess at an orbital-scale-resolution to address the variation of the clay mineral composition, and the implication of the dust provenance and climate reconstruction.

2. Material & Methods

Clay minerals were analyzed on samples at a 10 cm-interval in paleosol and a 20 cm-interval in loess units of the Stari Slankamen loess-paleosol sequence. XRD analysis was carried out using a PANalytical X’Pert PRO X-ray diffractometer with CuKα radiation, operating at 40 kV, 40 mA, at Taishan University. Semi-quantitative estimates of peak areas of the basal reflections for the main clay minerals were carried out on the Mg-EG curve using the MacDiff software.

The chlorite ratio was calculated as the integral area ratio of the chlorite diffraction peak at 0.47 and 0.7 nm (Al-chlorite/Fe-chlorite). The illite crystallinity was calculated as the Full Width at Half Maximum (FWHM) of the illite diffraction peak at 1.0 nm (Kübler and Jaboyedoff, 2000).

3. Results & Discussion

The results show that illite (range of 27–63%, average of 42%) and smectite (including illite-smectite mixed-layers, range of 9–49%, average of 32%) dominate the clay fraction, while chlorite (range of 12–22%, average of 17%) and kaolinite (range of 6–13%, average of 9%) are less abundant for the 12.70-m thick section.

The results suggest a mainly detrital origin for all of the clay minerals in the SS profile over the last glacial cycle, while the clay mineral assemblage in the lower part of V-S1 is partly modified by pedogenesis, characterized by the depletion of chlorite and illite and their transformation into illite-smectite mixed-layers or smectite.

The increased illite crystallinity, chlorite ratio, and the pedogenic formation of smectite only occurred in the lower part of paleosol V-S1, where there was the most intensive pedogenesis.

Both illite crystallinity and chlorite ratios are new sensitive weathering proxy for European loess.

Fig. 4. Comparison of the clay mineral composition of Carpathian Basin loess, Carpathian Basin fluvial sediments, Greenland Ice core Last Glacial Maximum (LGM) dust, and dust from East Asian and the Sahara deserts.

The smectite-rich characteristic of the glacial loess provides a diagnostic indicator for confirming local sources for the Carpathian Basin loess deposits, and that these sources made little contribution to the dust deposited in Greenland during the last glacial.

Fig. 5. Comparison of the chlorite chemistry of the last glacial cycle loess and paleosol from the SS section with samples from the Chinese Loess Plateau (CLP).

Fig. 6. Depth profiles of clay mineral contents, smectite/(illite+chlorite) [(SmI+Ch)], and chlorite ratios, illite crystallinity, and Chemical Index of Alteration (CIA), together with the pedostratigraphy.

Pedogenesis-induced variations of the clay minerals show that the pedogenic formation of smectite only occurred in the lower part of paleosol V-S1, where there was the most intensive pedogenesis.

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Fig. 7. Comparison of records of the chlorite ratio and illite crystallinity for the SS section with published proxy records of from Serbian loess, and with the global L.PH0 biotite group record.

The increased illite crystallinity, chlorite ratio, and the pedogenic formation of smectite and illite-smectite mixed-layers in the lower part of V-S1, i.e. during MIS 5e, are caused by increased precipitation. This strongly suggests that in a likely warmer future, increased precipitation would occur in northern Serbia.

Related Publication


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