Stable isotope study on the carbonate phases of the Basaharc loess-paleosol profile (Hungary)

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Loess and intercalated paleosols have been studied for many decades in Hungary, however, less is known about the forms of secondary carbonate components and their stable isotope characteristics.

Loess-paleosol sequences can record paleoenvironmental changes occurred during Pleistocene. Isotopic signatures of paleosol carbonates are commonly used to infer past ecologic and climatic conditions and shifts in the soil record. The study of paleosol carbonates, involving micromorphological investigation accompanied by stable isotope analysis (e.g. Pustovoytov & Terhorst, 2004), also enables the reconstruction of pedogenesis.

The former brickyard of Basaharc is located in the valley of the Danube at the northern end of the Transdanubian Range. The 20 to 25 m thick loess-paleosol sequence overlies the alluvium of the second terrace of the Danube, formed on Miocene andesite agglomerates (Pécsi & Hahn, 1987). Basaharc is the type section of three paleosol layers: the Basaharc Lower (BA) paleosol and the Basaharc Double (BD) paleosol, all of them are forest steppe soils (Pécsi & Hahn, 1987). The section also contains a fossil soil layer called Mende Upper (MF), which is the youngest one among the paleosols at Basaharc.

All the paleosol layers and the loess between them contains considerable amount of carbonate. Primary carbonate derived from carbonate rocks by eolian transport is essentially composed of calcite and dolomite grains, while secondary carbonate (calcite) formed during pedogenesis is usually present in various forms. Secondary carbonate precipitates can be large scale forms, e.g. nodules of variable size and impregnations in the soil matrix. Discrete small scale secondary carbonate precipitates less than a few millimetres in size are calcified root cells and hypocoatings in and around root channels and calcite filaments in pores and cavities. These small scale carbonate accumulations are also known from other European loess-paleosol sequences and their formation is related directly or indirectly to biological activity during pedogenesis (Becze-Deák et al., 1997).

Preliminary stable C and O isotope investigation was carried out on carbonate accumulations collected from each paleosol layer. Secondary carbonate rich samples from the B and C horizons of the paleosols were analysed, but microscopic and X-ray diffraction analyses indicated that samples also contained more or less primary carbonate. The presence of primary carbonate is problematic, since it is usually derives from Mesozoic marine carbonates (Manze et al., 1974), therefore it can shift the isotope composition of bulk samples toward higher values.

$\delta^{13}C$ values of carbonate accumulations range from -8.1 to -10.3‰ and their oxygen isotope composition is between -6.8 and -9.3‰ vs. V-PDB (Fig. 1). Data are close to the end-member isotope values typical for pedogenic carbonates formed in soil covered with C3 type paleovegetation. $\delta^{13}C$ and $\delta^{18}O$ values indicate moderate climatic conditions and different from those characteristic for periglacial environments.

Samples from the different paleosol layers do not show significant differences in isotope composition. One sample from the Mende Upper paleosol has higher C isotope value; however, the value possibly doesn't indicate any change in the paleoenvironment conditions since the sample contains the highest amount of primary carbonate among all. Beside pedogenic carbonate (s.s., that is formed in vadose environment) two carbonate accumulations formed under phreatic conditions were also analysed from the Basaharc Lower paleosol. The isotope composition of phreatic carbonate seems not to differ from that of the vadose carbonate.

Further (isotope) studies on soil carbonate, especially on small scale carbonate accumulations are planned with the exclusion of primary carbonate phases.

This study is supported by the Hungarian Research Fund (OTKA D 48631).

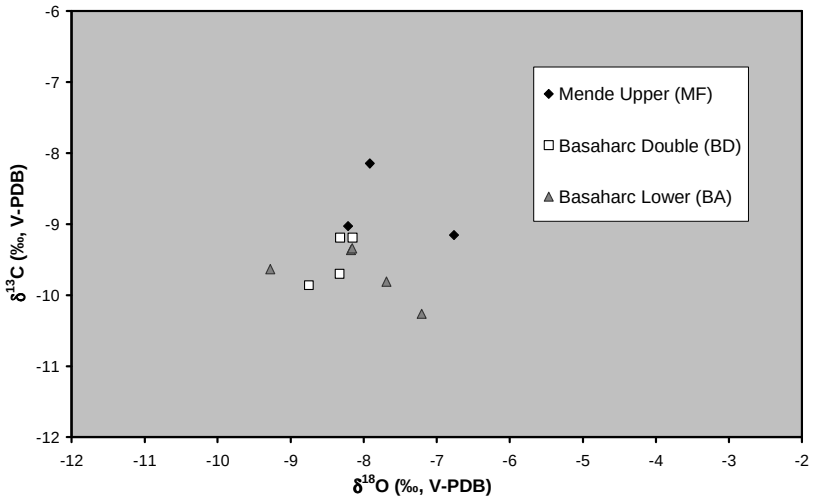

Fig. 1 Stable C and O isotope composition (in ‰ relative to V-PDB) of carbonate accumulations collected from the different fossil soil layers of the Basaharc loess-paleosol profile.

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