Ber. Inst. Erdwissenschaften K.-F.-Univ. Graz	Bd. 8	ISSN 1608-8166	Isotope Workshop Volume	Graz 2004

Stable isotope study in a paleosol horizon of the Quaternary Vár-hegy travertine (Budapest, Hungary)

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Beside the classic geological (sedimentological) and geomorphological studies, the investigation of travertines in Hungary recently turned to the geochemical analysis of sediment material and determination of possible links between geochemistry and lithofacies. Geochemical data, mostly stable C and O isotope compositions of Quarternary travertines occurring at several places in Hungary were recently published by Kele et al. (2003) and Földvári et al. (2003).

Quarternary travertine occurrences sometimes contain paleosol horizons which are result of former subaerial exposure periods. The study of paleosol horizons is very important in reconstructing past environmental conditions.

We studied the paleosol horizon intercalated into the travertine of the Vár-hegy (Castle Hill) in Budapest. One of the methods applied was stable isotope analysis of carbonate phases of the paleosol. Results were compared to the stable isotope composition of travertine, because comparison of data may indicate the amount of carbonate of pedogenic origin in the paleosol, thus providing information about the stage of development of pedogenesis.

The Quaternary sequence of the Vár-hegy starts with basal clastic strata, which are overlain by travertine. The lower part of the travertine is laminated, muddy and rich in terrestrial and freshwater fossils and plants. The top of the laminated travertine is a subaerial unconformity surface, on which a paleosol layer of 15 to 50 cm thickness was developed. The paleosol horizon has a great lateral extension (200 to 400 m) and is covered by a 7 to 8 m thick massive travertine poor in fossils and plants. The basal layer of paleosol is made of calcareous muddy sediments covering the karstic surface of travertine. The main level of paleosol consists of two horizons macroscopically; the lower one is richer in carbonate:

grains are penetrated and surrounded by white, thin and loose calcareous coatings and fibers at some places.

Microscopic observations on the paleosol and calcareous cavity fills revealed that they are mostly made up of mechanically reworked travertine clasts with a variable amount of allothigenic siliciclastic (e.g. quartz, mica and rock) fragments. Traces of carbonate reprecipitations can also be detected in thin sections: needle-fiber calcite in vugs and pores and micritic carbonate precipitations (hypocoatings) around pores of the paleosol and cavity fills. These secondary carbonate precipitations can result from biogenic processes during pedogenesis, therefore may indicate the possible influence of vegetation during their accumulation.

Bulk carbonate samples of paleosol and cavity fills (which do not contain secondary carbonate visible to the naked eye), paleosol samples rich in secondary carbonate and pure secondary carbonate precipitations were analysed for stable isotope composition. The oxygen isotope composition of the Vár-hegy travertine is between -17.7 and -13.7‰ (relative to V-PDB), while its carbon isotope composition has a narrow range from 1.1 to 2.1‰ (Földvári et al., 2003). Pure secondary (pedogenic) carbonate precipitations have significantly different isotope compositions (average: $\delta^{13}C$ = -7.3‰, $\delta^{18}O$ = -7.1‰) compared to that of the travertine (Fig. 1). Paleosol samples rich in secondary carbonate have intermediate isotope compositions between travertine and secondary precipitations, which indicate that they are mixtures of these two endmembers (Fig. 1).

Isotope composition of bulk paleosol and cavity fill samples partly overlaps with that of the travertine, but half of the samples have slightly lower $\delta^{13}C$ values (Fig. 1). Results indicate that bulk paleosol and cavity fill samples contain no or only minor amount of pedogenic carbonate. The amount of pedogenic carbonate can be estimated from the carbon isotope composition of the two endmembers (Nordt et al., 1998). Calculations show that bulk paleosol contains up to 16%, whereas bulk cavity fill contains up to 25% pedogenic carbonate.

Stable isotope results indicate that formation of authigenic carbonate is subordinate in the bulk paleosol material, which points to a weak *in situ* pedogenesis. Carbon isotope composition of pure secondary carbonate suggests that during pedogenesis the flora was mostly composed of C_3-type plants.

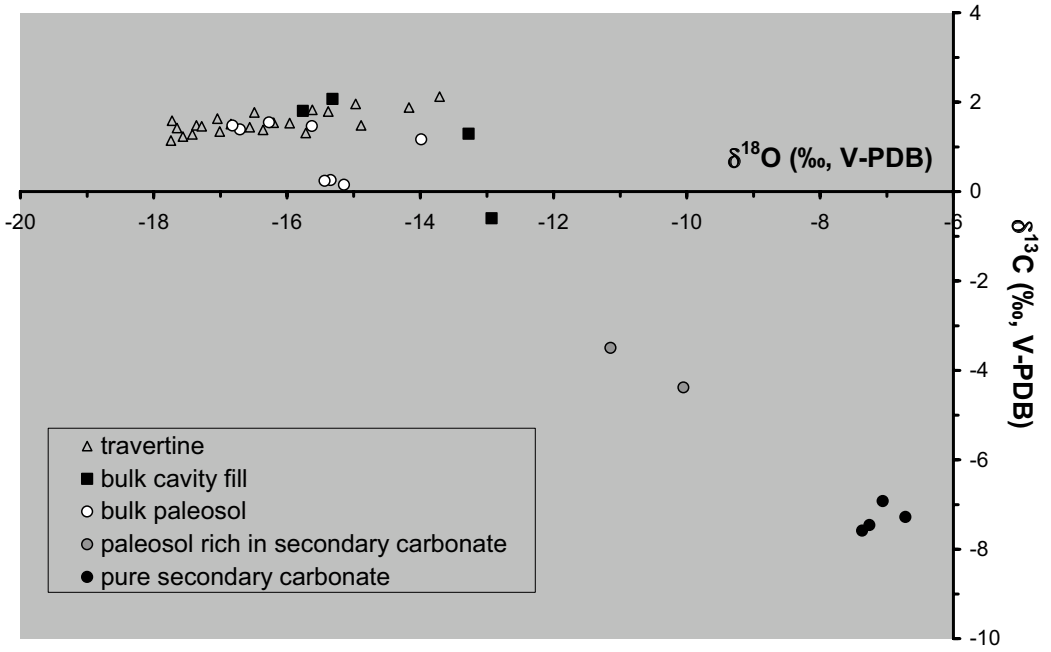

Fig. 1. Oxygen vs. carbon isotope composition (in ‰ relative to V-PDB) of bulk paleosol and cavity fill samples, paleosol samples rich in secondary carbonate and pure secondary (pedogenic) carbonate precipitations from the paleosol horizon of the Vár-hegy travertine. The isotope composition of the Vár-hegy travertine is mostly from Földvári et al. (2003).

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