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Chemical and isotopic composition of soil solutions from cambisols in Styria (Austria) – seasonal variations and experiments

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In most natural surroundings soil solutions are primarily gained from the uptake of meteoric water. Subsequently infiltration, capillary exchange, bioresponse, evaporation etc. result in complex and individual gas-water-solid systems. Knowledge on the chemical and isotopic composition of soil solutions and its evolution is highly relevant for environmental and forensic studies, but respective systematic and combined field and experiment studies are rare. Hence we investigated the composition of solids and interstitial solutions of individual soil horizons for three sampled cambisols in Styria (Austria).

The soil solutions were separated from the soils by compaction method at hydraulic pressures of 27.4 and 54.9 MPa, corresponding to pF values of 5.43 and 5.73, respectively (Böttcher et al., 1996, modified). The soils consist mainly of quartz, chlorite, muscovite and plagioclase with minor amounts of kaolinite, vermiculite and smectite due to weathering processes without any carbonates and without significant vertical variability in composition. The soil solutions contain Ca^{2+} , Na^+ , K^+ , Mg^{2+} , NO_3^- , Cl^- and SO_4^{2-} ions in decreasing order of concentrations. The pH ranges from 5.8 to 7.8. $\delta^{18}\text{O}$ and $\delta^2\text{H}$ values vary from -11.9 to -4.0 ‰ and -90.4 to -34.4 ‰ respectively. In principal, solutes, $\delta^{18}\text{O}$ and $\delta^2\text{H}$ values are higher concentrated and isotopically heavier, respectively, at pF 5.73 vs. 5.43.

Concerning seasonal variations two sampling campaigns were carried out (April and October, 2012). $\delta^{18}\text{O}$ and $\delta^2\text{H}$ values from October plot on the local meteoric water line, whereas values from April indicate an evaporation trend. Current degrees of evaporation can be calculated for distinct horizons of the three soils according to the approach by Mittermayr et al. (2013). The evaporation approach was verified by evaporation lab experiments using the above soils at a given humidity and temperature.

Moreover wetting experiments using deionized water with high $\delta^{18}\text{O}$ and $\delta^2\text{H}$ values were conducted to observe changes regarding pH, ion content, $\delta^{18}\text{O}$ and $\delta^2\text{H}$ values of the interstitial solutions as a function of matrix potential. Field-related and experimental results are discussed with respect to the impact of seasonality, evaporation, wetting and matrix potential-related interstitial distribution of the isotope-geochemical compositions of the separated soil solutions.

References

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