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Tracing stable isotopes (δ^2H and δ^{18}O) from meteoric water to spring-groundwater in small catchments of the Vienna Woods, Vienna, Austria

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The isotopic ratios of oxygen and hydrogen in water (2H/1H and 18O/16O) are important tools to characterise waters and their cycles. To trace the recharge area of spring waters the mean annual δ 18O values in precipitation changes due temperature and fractionation factors with altitude and a representative fraction infiltrates in the ground without any changes. In this study, the characteristics of δ18O and δ2H in rain water and groundwater from two springs have been used to understand the transformation mechanism of rain water to groundwater. Two small recharge areas in the Vienna Woods (outskirts of Vienna) above Flysch sandstones and marls were studied. One spring drains a small catchment totally covered with an old beech-oak forest and the other one a catchment covered by lawns and partly by weekend cottages. The springs were sampled every month and the precipitation in monthly samples in a Palmex rain-collector close by over a period of three years (2013-2016). The altitude of the recharge areas is in the range of 310 – 464 m with a yearly precipitation sum of 593-754 mm. The mean temperature of this Pannonian climate range in this period from 2.2° C in January and 24.1° C in July.
Precipitation, stream water and groundwater from each site plot approximately along the δ2H/δ18O slope (δ2H=7.9xδ18O+7.4) of local precipitation inputs. The spring water of the recharge area with mainly lawns and weekend cottages shows a clear seasonal variation between -11.84 ‰ in April and -9.99 ‰ in September. The recharge area with an old beech-oak forest shows a nearly constant δ18O-value of -11.0 ‰ in the spring water comparable to the mean of the winter half-year of the precipitation station. The isotope data and the considerable smaller discharge suggest that in the forested recharge area only precipitation water of the winter half year is added to the groundwater and rain water of the summer half-year is nearly totally transpired by the forest vegetation.
This indicates that shallow groundwater in forested recharge areas with moderate precipitation input cannot be traced by applying conventional altitude effects from precipitation data and estimates of the mean residence time (MRT) using the seasonal variation of the δ2H/δ18O from precipitation stations are misleading.