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Application of isotopes to estimate water ages in variable time scales in surface and groundwaters

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Water-Isotopes (2H, 3H, 18O) are ideal tracers not only to determine the origin of waters in precipitation, surface water (river + lakes) as well as in groundwater close to the surface and in deep groundwater but also the mean residence time (MRT) in many applied projects as drinking water supply, hydroelectric power plants, road tunnels etc. . Their application has a long history, but must be always evaluated by a feasible hydrogeological concept and/or other isotope and geochemical tracers.

In Alpine areas the retention of precipitation in form of snow and ice in the winter half year is indicated by the lowest 18O-values. The snow melt of the highest part of the recharge area is marked by the lowest 18O-values in the river water, but may not coincide with the maximum flow. Time-series of precipitation station in the mountain and on river station indicate the arrival of the peak snow-melt water in the river and in Low-land areas 4-7 month later. Tritium series indicate that MRTs of several Austrian rivers are in the range of 4 – 6 years.

The seasonal input variation of in 18O in precipitation and/or river waters can be used to calculate by lumped parameter models MRT of groundwater at a certain well and compare it with lysimeter measurements and transient model simulations. The MRT of the dispersion model is in good agreement with the estimated time calculated by the numerical transport model and the vertical lysimeter measurements.

The MRT of spring water was studied by several methods (3H/3He, SF6 and 85Kr) and a long time series of 3H-measurements. The gas tracers are in good agreement in the range of 6-10 year whereas the 3H-series model (dispersion model) indicate ages in the range of 18-23 years. The hydrogeological concept indicate that the precipitation infiltrates in a mountainous karst area, but the transfer into the porous aquifer in the Vienna Basin occurs either through rivers draining away in the basin or through the lateral transport from the karst area to the porous aquifer. This transfer leads to an equilibration with the atmosphere causing the age difference.