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# Uranium isotopes as tracers for groundwater - surface water interaction

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Uranium is a natural trace element in ground- and surface water. The activity ratio of dissolved uranium isotopes ($^{234}$U/$^{238}$U) in water is generally enriched with respect to $^{234}$U due to the alpha-recoil effect at mineral surfaces, which results in a higher release of $^{234}$U compared to $^{238}$U during weathering of rocks. This disequilibrium of $^{234}$U and $^{238}$U can be used as a tracer to identify groundwater inflow into surface water, a technique which we applied to the Weida river catchment in southeastern Thuringia in Germany. The study area has a size of 100 km$^2$. Land-use is mainly forestry and agriculture, and the prevailing geology is mainly shale. Most surface water samples yield $^{234}$U/$^{238}$U ratios larger than 1, which is a typical range where groundwater influence may be assumed. At base-flow conditions, a relation between uranium contents and $^{234}$U/$^{238}$U ratios could not be detected along the flow path. From short term measurements (3 months) a temporal dependency could not be found either. The large $^{234}$U/$^{238}$U ratio range seems to indicate that different uranium sources are mixing in the Weida river. From first isotopic analyses of nitrate it seems that the Weida is influenced by agriculture and may be locally affected by sewage. In contrast, a clear connection between discharge and uranium content for a surface runoff effect at the Weida was not recognized. The observed large range of $^{234}$U/$^{238}$U ratios may be a result of influences such as lithology, abundance of organic matter, fertilizer runoff and longtime water-rock contact. There seems to be greater variations of uranium-content and $^{234}$U/$^{238}$U ratio in the tributaries as in the Weida. We compare these results with data from a stormwater event, and use additional isotope tracers ($^{2}$H , $^{18}$O, $^{34}$S) for a better understanding of flow components in the catchment area.