

Application of stable isotopes to investigate intergranular-porosity aquifers: from groundwater origin to nitrate contamination issues

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Alluvial aquifers with intergranular porosity are commonly found in river valleys and serve as significant sources of groundwater worldwide. In the agriculture-intensive region of northwestern Croatia, particularly in the Drava and Mura River Valleys, these aquifers are instrumental for providing drinking water to the local population. However, high nitrate concentrations in these aquifers over recent decades have raised public concern about groundwater quality. Understanding the distribution of nitrates in groundwater and formulating appropriate management strategies for groundwater quality protection requires a comprehensive study of both groundwater and nitrate sources.

This work consolidates findings from various past and ongoing research projects (HRZZ-IP-06-5365 TRANITAL, COST CA19120 WATSON, IAEA TC RER 7013, IAEA CRP F31007, NITROVERT, and MOBODL-2023-08) to demonstrate the application of stable isotopes ($\delta^{18}\text{O}$ and $\delta^2\text{H}$ in water, $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ in nitrate) to identify recharge sources of groundwater and the origins of nitrate. Combined use of these isotopic tracers, hydrochemical parameters, and modeling techniques revealed the main mechanisms of groundwater recharge, including effective infiltration through the unsaturated zone, interactions between groundwater and surface water, groundwater mean residence time, contaminant attenuation processes within both saturated and unsaturated zones, and more.

The methodology used in this study can be employed for similar investigations aimed at assessing groundwater origin and nitrate contamination in watersheds with intensive agricultural activities.