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# Spatial Variability of Dissolved Organic Matter in the Ouysse Binary Karst System (Lot, France): A Molecular Window into Aquifer Dynamics.

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The Ouysse binary karst system (650 km$^2$), France's second-largest karst aquifer, is a vital water resource, supplying for about 80 000 inhabitants, yet its hydrological complexity, driven by a mixed recharge from diffuse infiltration of rainwater and three surface rivers[1], poses challenges for sustainable management. While traditional hydrogeological approaches have advanced our understanding of karst dynamics[2], the molecular composition of natural organic matter (NOM) remains an underexplored tracer of subsurface processes.

In this study, we investigated the spatial variability and molecular diversity of NOM across several sampling sites in the Causses du Quercy Regional Natural Park. Water samples were analysed for physico-chemical parameters (pH, temperature, conductivity), ionic composition (major anions/cations), and microbial community structure (metagenomic profiling). Dissolved organic matter was isolated using solid-phase extraction (PPL SPE) cartridges and characterized by ultrahigh-resolution Fourier Transform Ion Cyclotron Resonance Mass Spectrometry (FTICR-MS) and 3D-fluorescence spectroscopy.

Multivariate statistical analyses revealed distinct NOM composition correlated with recharge sources and hydrogeological connectivity, highlighting its potential as a high-resolution hydrogeological tracer. Specific molecular formulas and fluorescence properties varied significantly between sites, reflecting differences in water origin, residence time, and biogeochemical processing. These findings demonstrate that molecular-level NOM analysis can elucidate flow path, aquifer heterogeneity, and water mixing dynamics in karst systems.

By integrating advanced organic geochemistry into karst monitoring, this work offers a novel framework to improve our understanding of aquifer function and support data-driven water management in karst-dependent regions.

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[2]. Lorette, G. et al., J. Hydrol. 593, 125859 (2021).