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Spatial and temporal hydrogeological tracing methods from Dissolved Organic Matter (DOM) for karstic hydrosystems. Joint use of fluorescence and Electronic Paramagnetic Resonance (EPR) signals.

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Development and use of environmental tracing techniques using Dissolved Organic Matter (DOM) has been the subject of several scientific works during the last decade. Characterization techniques, like fluorescence Emission-Excitation Matrices (EEM) allowed identifying DOM sources and monitor them in mainland or marine hydrosystems. Moreover, hydrogeologists have already shown the significance of Total Organic Carbon content (TOC), used as fast seepage tracer in karstic aquifers.

This study aims the development of environmental tracing methods combining DOM fluorescence and EPR signals. These methods enable to characterize catchment area (spatial tracing) and calculate transit time (temporal tracing) in heterogeneous hydrosystems, like karst aquifers.

The Low-Noise Underground Laboratory of 'Rustrel – Pays d'Apt' (Vaucluse, France) offers a worldwide unique access to different kinds of unstructured flows of the karstic vadose zone, by cutting randomly the fault network of 'Fontaine de Vaucluse' carbonate system. Flows, with different hydrodynamic behaviours, can be studied in this underground laboratory. After identification of the different DOM sources (i.e. lithic and rendzic leptosols), joint use of EPR and fluorescence fingerprints of soil leachates and groundwaters allowed the development of three tracing methods.
Firstly, soil EPR fingerprints can be decomposed into specific EPR lines. Some of these lines can be found in groundwater EPR fingerprint, and therefore determining soil areas belonging to the catchment area (spatial tracing). Secondly, monitoring of fluorescence intensities (for certain excitation-emission couples) together with EPR line intensities studies, enabled to develop punctual transit time tracers, by marking a specific period of their variations (punctual event tracing). Thirdly, hydrochemical monitoring of these flows since 2002, has allowed understanding their hydrodynamic functioning. Therefore a relationship between fluorescence index (Humification IndeX [HIX]) and their mean transit time can be calibrated, allowing a continuous monitoring of the transit time (continuous temporal tracing). This relationship has been tested on two springs ('Vaucluse' and 'Albion' plateaus), giving good transit time estimations for hydrosystems which do not present mixture between recent and pluriannual waters.