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Microbial cytometric fingerprints shed new light on subsurface flow dynamics and mixing processes

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Over the course of the last decade, online flow cytometry (FCM) became an established method to continuously assess the microbiological quality of drinking water. In addition to the commonly derived total cell count, FCM also provides distinct cytometric fingerprints of microbial communities. Although microbes themselves are highly dynamic, the structure of microbial communities in different ecological habitats remains surprisingly stable. This study highlights the potential of microbial communities as a natural toolbox for hydrogeological tracing. By employing (online) FCM analysis across a variety of hydrogeological systems, we demonstrate that: (1) cytometric fingerprints enable to differentiate between groundwater types, (2) microbial community patterns uncover dynamic groundwater mixing, (3) microbial diversity at a riverbank filtration site is primarily governed by discharge events in the river rather than river restoration works, and (4) cytometric fingerprints reflect the highly complex flow pathways in a karst systems.