

Interests of long-term hydrogeological observatories for characterizing and modelling heterogeneous groundwater systems at multiple temporal and spatial scales: the example of Ploemeur, a crystalline rock aquifer (Brittany).

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Characterizing groundwater flows and surface interactions in heterogeneous groundwater systems such as crystalline fractured rock is often extremely complex. In particular, hydraulic properties are highly variable while groundwater chemical properties may vary both in space and time, especially due to the impact of groundwater abstraction. Here, we show the interest of hydrological observatories and long-term monitoring for characterizing hydrological processes occurring in a crystalline rock aquifer. We present results from the site of Ploemeur (French Brittany) that belongs to the network of hydrogeological sites H+ and the research infrastructure OZCAR, and where interdisciplinary and integrated research at multiple temporal and spatial scales has been developed for almost twenty years. This outstandingly heterogeneous crystalline rock aquifer is also used for groundwater supply since 1991.

In particular, we show how cross-borehole flowmeter tests, pumping tests and a frequency domain analysis of groundwater levels allow quantifying the hydraulic properties of the aquifer at different scales. In addition, groundwater temperature evolution was used as an excellent tracer for characterizing groundwater flow. At the site scale, measurements of ground surface deformation through long-base tiltmeters provide robust estimates of aquifer storage and allow identifying the active structures, including those acting during recharge process. Finally, a numerical model of the watershed scale that combines hydraulic data and groundwater ages confirms the geometry of this complex aquifer and the consistency of the different datasets. In parallel, this hydrological observatory is also used for developing hydrogeophysical methods and to characterize groundwater transport and biogeochemical reactivity in the sub-surface. The Ploemeur hydrogeological observatory is a good example of the interest of focusing research activities on a site during long-term as it provides a thorough understanding of both hydrological and biogeochemical processes that can be extended to many heterogeneous aquifers.