

## **How Groundwater Models Can Benefit from Near-Surface Seismic Data ?**

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Groundwater (GW) systems exist in dynamic balance with the climate and human pressure, connecting interfacing zones of recharge and discharge with multiple feedbacks. Quantifying the water flows at these interfaces is a key issue for hydrogeologists to consider for safe yield and good water quality. These interfaces are composed of various morpho-sedimentary units with highly contrasting geometries and lithologies. GW recharge and SW-GW exchanges cannot be directly measured. Consequently, it is necessary to model these fluxes, as they are dependent on the boundary conditions and spatial description of the hydrofacies, which are largely unknown and typically estimated via model calibration using conventional data (hydraulic heads and river discharge). Over the past decade, we have done our best to develop alternative methods to image the heterogeneities of the critical zone, describe the dynamics of its hydrosystems, and add seismic techniques to the hydrogeophysics toolbox.

We illustrate this last point with examples from the field. They show how a thorough interpretation of geophysical models can provide valuable prior information on the distribution of hydrofacies and calibrate the hydrogeological modeling domain. In addition, we raise the question of the propagation of uncertainty from the geophysical data to the hydrogeological model and suggest the use of alternative petrophysics to better interpret the data collected in the unsaturated zone.

especially in view of the ongoing changes in climate and land use Over the past decade, we have done our best to develop alternative methods to image the heterogeneities of the critical zone, describe the dynamics of its hydrosystems, and add seismic techniques to the hydrogeophysics toolbox. With the growth of long-term observation infrastructures in this field, the geophysical tools recently developed by the community tend to be viewed as state-of-the-art geophysical characterization methods mainly deployed to augment observatory and network databases. A major problem is that geophysical results are mostly just sets of parameters, in other words "models", deduced from sparse data sets and poorly posed problems. They certainly cannot be considered as data by observatories. In order to better transport information from the data into models that could be safely exploited by non-geophysicists, we need to: increase the extent and throughput of our surveys; optimize our acquisition configurations with respect to the target of interest; greatly increase our spatial and temporal sampling capabilities; automate our tedious processing workflows; and improve, if not completely revise, our inversion tools. We illustrate this last point with examples from the field. They show how a thorough interpretation of geophysical models can provide valuable prior information on the distribution of hydrofacies and calibrate the hydrogeological modeling domain. In addition, we raise the question of the propagation of uncertainty from the geophysical data to the hydrogeological model and suggest the use of alternative petrophysics to better interpret the data collected in the partially saturated zone.