Geophysical characterization of a Limestone Heterogeneous Vadose Zone – Beauce Aquifer (France)

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In the Region Centre - Val de Loire, groundwater quality of the largest reservoir in France is menaced by strong pressures related to high agricultural activities. Scientific efforts are being made to well understand both hydrological systems and water transfers in the Vadose Zone (VZ). The O-ZNS observatory, currently under development at an agricultural site in Villamblain (Centre Val de Loire, France), will provide a detailed insight of hydrological transfer processes in the VZ. It is based on an exceptional well (20m-depth and 4m-diameter) associated with several surrounding boreholes. These will allow, an accurate characterization of the heterogeneous structure of the unsaturated limestone, by geophysical imaging and a monitoring of the hydrogeological parameters by various techniques. The aim is to understand the hydrogeological processes governing water transfer in heterogeneous limestone VZ, and to elaborate hydrogeological models integrating these processes.

Our approach for this first characterization of the O-ZNS site is mainly based on a qualitative comparison between surface and borehole geophysical prospections and laboratory tests. Geophysical prospection consisted especially in 2D Magnetic Resonance Sounding (MRS), which allows non-invasive determination of water content in the VZ. Several sizes of MRS loops were tested to explore scale effects and different measurement configuration were applied for filtering. MRS results are compared with laboratory tests (petrophysical, mineralogical and hydraulic properties) and the other geophysical prospection methods, such as neutron logging and cross-borehole radar tomography results.

These preliminary results are used in order to define MRS monitoring measurement configuration including loop size and position, as well as identify optimized filtering strategy and measurement time frequency. Finally, these results will provide the baseline for the research projects, which aims at determining MRS contribution to the improvement of taking into consideration scale variability and heterogeneity in water transfers models within the vadose zone.