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Combining MRS and ERT Surveys to Characterise Hard Rock Aquifer Properties

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As a consequence of the implementation of the Water Framework Directive across Europe, water resources management in Europe requires increasingly complex quantitative management tools on a catchment scale. Numerical groundwater models are frequently employed in this process. A limitation to the modelling approach is commonly the lack of certainty with regard to the required model input parameters such as aquifer transmissivity T, aquifer storage S and effective porosity ne due to the limitation of direct physical data at a relevant scale. Fractured bedrock aquifers, as encountered across >60% of the Island of Ireland, pose a particular challenge in this context, as point-based physical measurements of hydrogeological parameters (such as derived from traditional borehole observations and testing) often fail to adequately characterise these complex aquifer systems at a scale relevant to better understand groundwater flow paths and contaminant transport processes. The presented study completed a Magnetic Resonance Sounding (MRS) survey along a hillslope transect through a case study catchment underlain by Precambrian weathered-fractured bedrock aquifer units in County Donegal, Ireland. The study highlighted the feasibility of applying the Magnetic Resonance Sounding (MRS) technique for determining aquifer effective porosities in fractured bedrock environments at the decametre scale. In combination with data from previously completed Electric Resistivity Tomography (ERT) surveys along the approx. 1500 m catchment transect, the study was able to resolve the variation in aquifer porosities across the weathered and un-weathered vertical profile of the fractured bedrock units ranging from 0.3 to 3.4 %, thus taking advantage of both the high spatial resolution of the ERT data for imaging structural bedrock geometry and the direct measurements of aquifer storage properties from the MRS survey.