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Integrating geophysical data and upscaling techniques to support regional groundwater flow modelling: A practical example of the Lagan Valley, Northern Ireland.

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When studying heterogeneous aquifer systems, especially at regional scale, a degree of generalization is anticipated. This can be due to sparse sampling regimes, complex depositional environments or lack of accessibility to measure the subsurface. This can lead to an inaccurate conceptualization which can be detrimental when applied to groundwater flow models. It is important that numerical models are based on observed and accurate geological information and do not rely on the distribution of artificial aquifer properties. This can still be problematic as data will be modelled at a different scale to which it was collected. It is proposed here that integrating geophysics and upscaling techniques can assist in a more realistic and deterministic groundwater flow model. In this study, the sedimentary aquifer of the Lagan Valley in Northern Ireland is chosen due to intruding sub-vertical dolerite dykes. These dykes are of a lower permeability than the sandstone aquifer. The use of airborne magnetics allows the delineation of heterogeneities, confirmed by field analysis. Permeability measured at the field scale is then upscaled to different levels using a correlation with the geophysical data, creating equivalent parameters that can be directly imported into numerical groundwater flow models. These parameters include directional equivalent permeabilities and anisotropy. Several stages of upscaling are modelled in finite element. Initial modelling is providing promising results, especially at the intermediate scale, suggesting an accurate distribution of aquifer properties. This deterministic based methodology is being expanded to include stochastic methods of obtaining heterogeneity location based on airborne geophysical data. This is through the Direct Sample method of Multiple-Point Statistics (MPS). This method uses the magnetics as a training image to computationally determine a probabilistic occurrence of heterogeneity. There is also a need to apply the method to alternate geological contexts where the heterogeneity is of a higher permeability than the host rock.