Geophysical Research Abstracts
Vol. 17, EGU2015-13965-2, 2015
EGU General Assembly 2015

Quantitative analysis of fault and fracture systems and their impact on groundwater flow in Irish bedrock aquifers

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Faults and fractures are the most important store and pathway for groundwater in Ireland's bedrock aquifers either directly as conductive flow structures or indirectly as the locus for the development of dolomitised limestone and karst. Through quantitative analysis in a range of Irish bedrock types, we have developed generic conceptual models of depth dependency, lithological control and scaling systematics for the different fault and fracture systems, linked to observed groundwater behaviour. Quantitative characterisation of the main post-Devonian fracture systems in over 70 outcrop, quarry, mine and cave locations shows that their geometry and nature varies with lithological sequence and with spatial controls, such as depth and regional variations in deformation style and intensity. The nature of fracturing and faulting directly controls aperture distribution, size and geometry, which in turn influences karst conduit geometry in limestones. Determining these attributes is, therefore, key for groundwater flow parameter estimation. We briefly describe how the most transmissive structures (NNE-NNW Variscan veins and Tertiary strike-slip faults), and the most common structures (joints) can be linked to critical groundwater parameters, such as transmissivity, storage coefficient and connectivity, at both regional and local scales. We show that for some of these fracture systems, structural parameters critical to groundwater flow (including orientation, spacing and aperture) can be used to compute ranges of hydrogeological parameters (fracture porosity and permeability), which in combination with hydraulic data (groundwater levels, volumetric flow and recharge) can be used to provide constraints on permeability anisotropy and heterogeneity at different scales.