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Evidence for deep sub-surface flow routing in forested upland Wales: implications for contaminant transport and stream flow generation

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Abstract. Upland streamflow generation has traditionally been modelled as a simple rainfall-runoff mechanism. However, recent hydrochemical studies conducted in upland Wales have highlighted the potentially important role of bedrock groundwater in streamflow generation processes. To investigate these processes, a detailed and novel field study was established in the riparian zone and lower hillslopes of the Hafren catchment at Plynlimon, mid-Wales. Results from this study showed groundwater near the river behaving in a complex and most likely confined manner within depth-specific horizons. Rapid responses to rainfall in all boreholes at the study site indicated rapid recharge pathways further upslope. The different flow pathways and travel times influenced the chemical character of groundwaters with depth. Groundwaters were shown to discharge into the stream from the fractured bedrock. A lateral rapid flow horizon was also identified as a fast flow pathway immediately below the soils. This highlighted a mechanism whereby rising groundwater may pick up chemical constituents from the lower soils and transfer them quickly to the stream channel. Restrictions in this horizon resulted in groundwater upwelling into the soils at some locations indicating soil water to be sourced from both rising groundwater and rainfall. The role of bedrock groundwater in upland streamflow generation is far more complicated than previously considered, particularly with respect to residence times and flow pathways. Hence, water quality models in upland catchments that do not take account of the bedrock geology and the groundwater interactions therein will be seriously flawed.

Keywords: bedrock, groundwater, Hafren, hillslope hydrology, Plynlimon, recharge, soil water, streamflow generation

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