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Palaeo-Root Hole Influenced Aromatic Hydrocarbon Transport Within a Clay Stratum

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Clay strata have in the past been assumed to provide good protection of underlying aquifers. Increasingly, however, this assumption is proving erroneous as the important role of micro-scale fractures or heterogeneities present within a clay are recognised. Our research based at a former UK industrial facility contaminated with aromatic hydrocarbons aims to assess transport of dissolved-phase aromatic solutes within a discrete clay bed underlying the site. In particular, the control that palaeo-root holes sporadically present in the clay stratum exert on transport is presented. The clay stratum studied is a 1-2 m thick lacustrine clay of Holocene age at around 6 m below ground surface surrounded above and below by a sandy aquifer. Downward hydraulic gradients of 0.3-0.5 occur across the clay. Detailed depth profiles were determined from cores retrieved from thirteen locations. Two principal types of aromatic hydrocarbon – clay invasion profiles were identified exhibiting various degrees of heterogeneity: (i) diffusion-based invasion into fairly homogeneous clays; (ii) advection dominated invasion thought primarily through connected palaeo-root holes. Root connectivity has been demonstrated through serial sectioning of the advection dominated cores; the hydraulic conductivity of which are found to be around 2.4 x 10^{-1}m/d. Connectivity in the diffusion based cores was not present and hydraulic conductivity values were approximately 3 x 10^{-5}m/d. Supporting interpretation via 2D models (FRACTRAN) is also presented. Overall results to date suggest that where the clay deposits are homogeneous and diffusion dominant they will offer significant protection to lower aquifers. Conversely, clays with root holes tend to be more advection dominated and much more likely to be penetrated by contaminants particularly where hydraulic gradients across the clay are large.