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Characterising pesticide residence and transport processes through dual porosity aquifers

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Agrochemical contamination in groundwater is an increasing problem that poses a significant long term threat to water quality and is of concern for legislators, water utilities and consumers alike. In the dual porosity aquifers common in the UK, movement of pesticides and their metabolites through the unsaturated zone to groundwater is generally considered to be through one of two pathways; a rapid by-pass flow and a slower 'piston-flow' route via the rock matrix. However, the dissolved form or 'colloidal species' in which pesticides move within the water body is poorly understood. Following heavy rainfall, very high peaks in pesticide concentration are often observed in shallow UK aquifers. These concentrations might be well explained by colloidal transport of pesticides.

We have sampled a Chalk groundwater beneath a deep (30 m) unsaturated zone known to be contaminated with the pesticide diuron. Using a tangential flow filtration technique we have produced colloidal fractions from 0.45μm to 1kDa. In addition, we have applied agricultural grade diuron to a typical chalk soil and created a soil water suspension which was also subsequently fractionated using the same filtration system. The deep groundwater sample showed no evidence of association between colloidal material and pesticide concentration. In comparison, despite some evidence of particle trapping or sorption to the filters, the soil water clearly showed an association between the $<$0.45μm and $<$0.1μm colloidal fractions which displayed higher pes-

ticide concentrations. Degradation products were also observed and found to behave in a similar manner to the parent compound. Although colloids can be generated in the Chalk soil zone, it appears transport to depth in a colloidal-bound form does not occur. Comparison with other field and monitoring studies suggests that rapid by-pass flow is less likely to occur beneath 5 m. Therefore, shallow groundwaters are most at risk from rapid transport of high concentrations of pesticide-colloidal complexes. The presence of a deep unsaturated zone will mean that most of the colloidal-complexes will be filtered by the narrow chalk pores and the majority of pesticide transport will occur in a ‘dissolved’ form through the more gradual ‘piston-flow’ route.