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Impact of Intermittent flow events on Generation and Mobilization of Colloidal Particles in Surface-Exposed Fractured Chalk

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A series of field and laboratory experiments was conducted to study the mechanisms of particle detachment and mobilization in fractures crossing unsaturated chalk, and their subsequent transport in saturated factures. Experiments simulating intermittent flow events along fracture surfaces were carried out in the laboratory. Impact of flow events of high-ionic strength wastewater as well as rainwater was explored. In the field, water was allowed to percolate from the land surface via a discrete fracture into a compartmental sampler installed inside a horizontal corehole located 1 m below the surface. The mass, size distribution and composition of the particles drained from the fracture voids were examined, along with flow rates and salt dissolution.

Most of the particle and solute release in the drained effluents occurred during the first few hours of flow, but erratic pulses of particle release were still observed after long periods of time. Most of the detached particles had a mean diameter of >2 μm, while the mobile colloidal phase in the groundwater had a mean diameter of ~ 1 μm.

The results of this study suggest that: (1) particle detachment causes flow-rate variability in an unsaturated fracture; (2) the mechanisms of particle detachment and salt dissolution within the fracture are linked; (3) although most of the detached particles are large and likely to accumulate inside fractures, some colloidal particles may be transported to the groundwater; and (4) once the colloids reach the saturated fractures, their transport in naturally fractured chalk is likely to occur.