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Investigating the Interactions between Sandstone and 100 nm Silica Colloids

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As part of an investigation of the role of inorganic colloids in the movement of viruses through sandstone groundwater systems, the attachment interactions between synthetic 100 nm Silica colloids and the sandstones are being investigated. The sandstone used in the experiments is from the UK Triassic Sherwood Sandstone Group, a typical weakly to well-cemented red bed fluvial/aeolian sequence of quartz sandstones with significant feldspar and lithic clast populations, containing clay minerals, carbonates, and iron and manganese oxides/hydroxides. The dominant colloid composition in the sandstone groundwaters is silica, at ˜ 1-5 ppm. A laser light-scattering device was built for detecting particulates on-line. Initial experiments showed that the particulates released from traditional batch reactors made attachment determination impossible. To circumvent this problem, the $<$ 0.25 mm fraction of the sandstone was cemented to the two larger surfaces of an experimental cell consisting of two plates sealed around their edges. The separation of the plates is effectively 0.10 mm. Colloid solutions of different concentrations were then injected through the cell, and their breakthroughs recorded on-line. A mass balance allowed the amount of attachment to be calculated. The amount of sediment available for interactions was estimated using sorption of rhodamine. The coarser fraction of the sandstone was investigated using a flow-through cell: the fine fraction was removed through flushing.

The results for concentrations from 2.5 to 20 ppm indicate that the attachment capacity at ambient pH is large-enough to keep the concentrations below 90% of the injection value for well over 100 cell volumes. The proportion of colloids attached increases with concentration. Most attachment is to the fine fraction. The attachment rates and capacity appear to imply that the residence time of the colloids in the field system is very short. The significance of this is now being considered, and further

experimentation will include the use of intact sandstone columns.