Microparticles in Wellwaters

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Microparticles (μPs) are here defined as particles larger than 1μm, i.e. larger than the usually-defined colloidal range. High concentrations of particles, and in particular μPs, in wellwaters can seriously affect the operation of many public supply wells in particular, either through exceedance of the low 1 NTU quality limit or through interference with, e.g., NO_3 treatment plants: in many cases high turbidity significantly reduces the usage of affected wells. Turbidity is also of major concern for situations where water is pumped into wells, e.g. for aquifer storage and recovery schemes and for reinjection of water in open loop heat recovery systems. Although turbidity has been long measured, there are no generally accepted quantitative methods for predicting concentration variation that could be used to design operational practice or remedial procedures, though some research is being developed by consultants MWH on particle movement in chalk aquifers (M. Anderson (MWH), pers comm.).

We have collected a large dataset on particle concentrations from sandstone boreholes as a by-product of other research work using the University campus research well-field. These data include online particle sizing from both packer testing of specific sandstone units and full borehole pumping tests. Preliminary examination suggests repeatable concentration / time patterns are seen: we hypothesize that these patterns should be predictable, and that it should be possible to develop a tool that could be used to design management practice to minimize particle concentrations.

Thus the proposed project would involve the development of quantitative models of μP concentrations as a function of well design, lithology, pumping regime, and time. The data needed would come initially from the datasets already obtained, but these would be supplemented by further data collected by experimentation using the University research well-field, backed up by laboratory work.

The project would be suitable for a bright geoscience, engineering, or physics graduate with numerical skills and an ability to undertake both modelling and field work. Aside from developing tools that would have international applications, the student would receive training in both groundwater hydraulics and contaminant transport, and on graduating would be in an excellent position to enter either groundwater research or consultancy.

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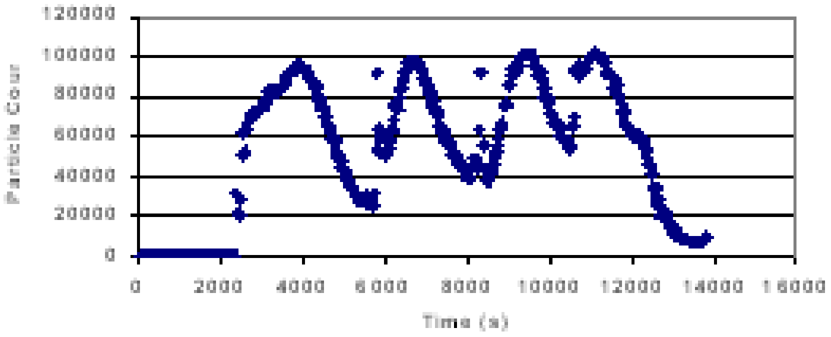
Further Project Details

Aim: To develop a quantitative method for predicting time & history -dependent particle concentrations in sandstone wellwaters that can be used in developing management strategies for minimizing particle yields.

Approach: **1.** Literature review to bring together ideas and methods from the disparate disciplines to which particle transport is relevant, the latter including geotechnics (including hydrofracturing), chemical engineering, waste water engineering (including filter theory), and sediment process engineering/geomorphology as well as groundwater studies. This cross-disciplinary review will inform the approach to conceptual and quantitative model design, and possibly to measurement strategies. **2.** Collation and re-examination of existing wellwater data (e.g. Figure 1) to derive empirical descriptions of particle concentration variation through time. **3.** Design and completion of field experiments using the University well-field facility. **4.** Design and completion of laboratory experiments to support the field investigations as necessary. **5.** Sampling and characterization (mineralogy, chemistry, sizing, and surface properties) of particles to determine particle stability, straining potential, and provenance, and thereby potential pathways. **6.** Using the analysis results from 2, 3, 4, and 5, develop a conceptual model covering genesis, source/release, transport processes, and attenuation. **7.** Using 6, develop a quantitative description of the system (we envisage that this will be based on the conceptual model, but would have empirical rather than detailed process-based representations); this modelling work will almost certainly require iteration with previous steps.

Figure 1: Particle concentration variation with time over a period of about 4 hours during which four changes in pumping rate occurred: the four plots are for different sized particles, 5-10 μm.



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