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MAKING THE MOST OF LONG-SCREENED WELLS IN GROUNDWATER INVESTIGATIONS

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Introduction

Effective groundwater management depends on understanding aquifer characteristics, flow dynamics and water quality at a representative scale. Wells are expensive to install, so the economical approach is to use available infrastructure where possible. However, wells installed for other purposes (e.g. water production) often have much longer screened or open intervals than wells designed for collecting scientific data. This means that, with traditional methods, key data – like hydraulic properties, water level and water quality – are averaged over an unhelpfully large interval of the aquifer system. So, such wells tend to be underused or even misused in groundwater investigations. The aim of this talk is to show that, with a little extra work and appropriate methods of measurement and analysis, long-screened wells can in fact provide valuable scientific data and insight for groundwater investigations. In particular, it is possible to determine the intersected hydraulic conductivity and head distribution and obtain native groundwater samples from discrete zones.

Method

This talk draws on knowledge developed for a study that used environmental tracers to examine groundwater recharge processes and residences time in the complex geological setting of the Pilbara region of Western Australia. In this study we: (1) numerically modelled the effects of intraborehole flow on purging and sampling long-screened or open wells (Poulsen et al. 2018); (2) measured the in-well flow regime in ambient and pumped conditions with a borehole electromagnetic (EM) flowmeter; (3) developed and tested a new constant-rate tracer dilution method to determine the in-well flow regime in pumped conditions (Poulsen et al. in prep.); (4) developed a depth-specific sampling strategy, exploiting the ambient and pumped in-well flow regimes to target discrete zones that produce native groundwater (Poulsen et al. in prep.); and (5) sampled environmental tracers from long-screened wells and a multi-depth nest of piezometers to investigate groundwater residence times.

Results

The wells used in this work had been un-pumped for several years, so the intraborehole flow plumes were large and it was more practical to avoid sampling them, rather than attempt purging. While pumping, the in-well flow profiles measured with the EM flowmeter clearly showed the main inflow zones, and the proportion from each zone. We produced very similar flow profiles with the new constant-rate tracer dilution method. This involved constantly injecting a tracer at one end of the screen while constantly pumping from the other end. The tracer was drawn towards the pump and diluted in proportion to each inflow. Tracer concentration profiles were collected at regular intervals, and at steady-state they were translated into flows by applying a solute mass balance model. Significant vertical heterogeneity was observed, with the majority of yield sourced from sub-intervals within the wells. Two had strong ambient flows (6-7 L/min) that could be sampled simply by placing the low-rate (0.5 L/min) sampling pump in the higher head zone. Purging was unnecessary because native groundwater was constantly flowing through the well. One well had weak upward ambient flow (<1 L/min), which was enhanced by pumping. Another had negligible ambient flow, so it would produce native groundwater after a modest purge. Preliminary results of sampling show no clear stratification of basic water chemistry, some significant differences of Radon, while Carbon-14 indicates consistently old (10-14k years) groundwater at all depths. CFC and Helium samples are being analysed at GNS Science Water Dating Lab and University of Utah respectively (at the time of writing).

References

Poulsen, D.L., Cook, P.G., Simmons, C.T., McCallum, J.L., Dogramaci, S., 2018. Effects of intraborehole flow on purging and sampling long-screened or open wells. *Groundwater*. doi: 10.1111/gwat.12797