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Water sampling in low productive boreholes: how to ensure of the representativeness of sampling?

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Good practices of wellbore purging advice to draw three to five times the volume of the water column prior to sample. An extensive literature in the past 20 years has established the biases that may be linked to this procedure with emphasis on contaminant sampling and the benefit low-flow sampling may have to avoid redistribution of contaminants in boreholes because of the flow-weighted average character of pumping (Einarson, 2006, Handbook Environmental Site Characterization and Ground-Water Monitoring). Low-flow sampling may produce flow-biased samples if operated in long-screened boreholes where vertical gradients exist (McMillan et al., 2014, J. Contam. Hydrol. 1699, 50-61) and is better suited for high permeability boreholes (ISO Standards).

Water sampling in low permeability aquifers remains challenging especially for boreholes drilled for water table level monitoring (long-screened boreholes; pumps may not be lowered down in the screened interval). Fluid Electrical Conductivity logging prior to pumping and sampling may help in locating the productive levels albeit the information obtained under ambient flow conditions may be of less relevance than the data collected using salt injection (e.g. Lasher and Nel, 2013, Groundwater Division Conference, Durban). Fiber optic Distributed Temperature Sensing may also resolve hydraulic (McMillan, 2015, PhD dissertation) but is not of common use.

We refer to investigations performed in two boreholes (Labruguière and Valdurenque) of low permeabilities (10^{-6} to 10^{-7} m.s^{-1}), located in detritic formations in SW France. These two boreholes, of 170 m and 123 m depth respectively, have long screened sections (128-170 m and 75-123 m respectively). With such geometries, the submersible pump cannot be placed in the screened interval to perform volume purge. This raises the question of how long the pumping has to be done to get water representative of the downhole chemistry. The purge of three times the volume of the water column is unrealistic. For Labruguière borehole, it would take 12 hours cumulated at $\leq$1 m^3.h^{-1} pumping rate, each session cannot last more than 2 hours (dewatering) and 12 hours are needed to recover the water table level.

We thus refer to deep sampling to assess the usefulness of such a method. Several levels were determined on the basis of ambient logging (temperature, conductivity, pH, dissolved oxygen, redox potential). In parallel we use pumping to assess the purge process inside the borehole and determine the minimum amount of drawn water needed to get water from the screens. This also highlights that alternative method to judge of representativeness, such as stabilization of physico-chemical parameters, may lead to false positives, i.e. the parameters were stabilized but the water chemistry was not that of the screened section. Three cycles of logging – deep sampling – pumping were done in each borehole. Based on field data and laboratory analyses, it appears that a protocol for deep boreholes characterization may refer to 1) borehole logging (information on ambient structure of the water column), 2) slight solicitation of the borehole by pumping (renewal of water at productive levels), and 3) deep sampling at the depth(s) suggested by borehole logs.