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Improving the detection of hydraulic conductivity contrasts in heterogeneous aquifers by using Active-DTS method in boreholes sealed with polyacrylamide (PAM) gel

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In recent years, many efforts have focused on techniques using temperature for studying hydrogeological processes. Moreover, the development of distributed temperature sensing (DTS) enable monitoring of temperature data continuously in space (decimeter scale resolution along the fiber) and time (measurements at time intervals of less than 1 min). Recently, Active-DTS (A-DTS) approach was shown to provide measurements of fluid fluxes in boreholes. The method consists of heating along the entire length of the borehole or at a point location while measuring the temperature response in the borehole with a fiber optic (FO) cable. The measured temperature response depends on the heat input, the cable deployment, the lithology as well as on groundwater flow rate in the borehole and in the aquifer. The A-DTS method was successfully used to detect horizontal and vertical groundwater flux in different types of aquifers. Nevertheless, the temperature gradients induced either by geothermal heat or by active heating generally induce thermally driven convection in the water column of an open borehole and thus create irregularities within the temperature data.

In this contribution we demonstrate how a new temporary borehole sealing technique using soft grains of polyacrylamide (PAM) gel as a sealing material can be used during A-DTS borehole tests thus providing improved hydrogeological characterization of heterogeneous aquifers. Active heating laboratory and field experiments combined with temperature measurements along fiber optic cables were conducted in water-filled boreholes and boreholes filled with soft grains of polyacrylamide gel. We found that borehole flow dynamics, while conducting A-DTS borehole tests, prevents from localizing low- and high-K zones. The gel packing, with a permeability similar to open gravel, is shown to minimize the effect of free convection within the well column and enable detection of thin zones of relatively high or low velocity in a highly transmissive alluvial aquifer, thus providing a significant improvement compared to temperature measurements in open boreholes. Finally, we discuss other possible applications of this innovative and cost-effective approach for hydrogeological characterization of aquifers.