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Reply on RC1

Jesús Díaz-Curiel

Community comment on "Advances in the hydraulic interpretation of water wells using flowmeter logs" by Jesús Díaz-Curiel et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-380-CC1, 2021

We thank you for your review and comments; we look forward to providing a satisfactory response.

In L423 it is explained why in this study turbulence is not considered a factor that justifies the anomalous behavior, as the flow in groundwater in granular media does not reach the turbulent regime. On the other hand, the subdivision of the well into stretches is done precisely to avoid the influence of differences in skin effects on the flowmeter results (L78).

In many of the papers involving USGS technicians that we had reviewed (Keys and Sullivan, 1979; Molz et al., 1990; Hess et al., 1991; Crowder et al., 1994; Gossell et al., 1999; Wilson et al., 2001; Johnson et al., 2005; Lane et al., 2002; Williams, 2008; Garcia et al., 2010; Paradis et al., 2011) we have not found that hydraulic heads differences in the assessment of aquifer permeability in multi-zone wells have been discussed in great detail.

We had not cited Paillet's publications, because we had understood that the methodology shown was largely based on the measurement of flowmeter-logs in ambient condition and with flow rates much lower (<5 l/min = 0.0014 l/s) than the case analyzed in this study. With reference to Paillet et al. (2000, Flowmetering of drainage wells in Kuwait city, Kuwait, Journal of Hydrology, v234, p208) and Paillet (2001, Hydraulic head applications of flow logs in the study of heterogeneous aquifers, Ground Water, v39, p667), the methodology to obtain the different hydraulic heads is not added in our new version, because we could not find the description of the procedure followed to obtain these values.

Following your comments we are going to make the following modification: In L53 "no methodology has been published to quantify its effects" to be more precise, we will add "in water wells in large continental detrital basins".

Paillet (1998, Flow modeling and permeability estimation using borehole flow logs in heterogeneous fractured formations, Water Resources Research, v34, p997) showed the results of two flowmeter logs obtained with a heat-pulse flowmeter (lower limit of ~0.1 l/min and upper limit of ~20.0 l/min) in Waupun (Wisconsin, USA). These flowmeter logs was measured under ambient and injection conditions at about 4 l/min, and analyzed for pumping or injection rates typically 1-5 l/min. We think that the relationship used to

estimate the transmissivity T_k of each fracture k, starting from the flow into the borehole q_k is: $q_k^b - q_k^a = 2 \cdot \pi \cdot T_k \cdot (w^a - w^b) \cdot \ln(R_0/r_w)$ where a and b address the ambient and stressed conditions respectively, $w^{a,b}$ is the water level in the borehole, R_0 is the distance to the "outer edges" of the fracture, and r_w is the borehole radius. This relationship does not depend on the unknown value of the far-field head in the aquifer H_k. Later, in Paillet (2000, A field technique for estimating aquifer parameters using flow log data, Ground Water, v38, p510) $\sum T_k \cdot H_k = w^a \cdot \sum T_k$ is used to determine T_k. In this work was stated that: "*the results of high capacity tests, where the effects of ambient hydraulic-head differences would not be significant*", hydraulic head values (4.54, 4.91, 4.91 and 4.91 m below ground level) are presented for the four productive stretches in one of the boreholes analyzed, although the process followed is not reflected in this paper. In Paillet (2001, cited above) the hydraulic head estimates (cm above open hole water level) in the same borehole (+28, -11, -11, and -11 cm above open hole water level) are shown. Based on this methodology, Day-Lewis et al. (2011, A computer program for flow-log analysis of single holes (Flash), Ground Water, v49, pp926-931) presented a computer program for flow-log analysis of single holes applicable up to 10 levels, in which the hydraulic head of each zone is determined by minimizing the differences between the flow rates obtained and those of the model, and between borehole's water level and far-field heads.

Following the reviewer's comments, in L222 we are going to add: “The main differences with the method used by Paillet (1998) are that we have chosen to use the Rehfeldt relationship (Eq. 2) for permeability instead of the Davis and DeWeist relationship (1966) relation for transmissivity, given that the thickness of the layers and the productive sections are taken into account. It has also been considered that the different hydraulic heads are below the static water level (the water level in ambient conditions from Paillet, 1998). The procedure developed is based on the linearity of the hydraulic behavior of the aquifer sections and each section is treated separately.”