Delineation of the aquifer structure and estimation of its hydraulic parameters on the flanks of Mount Meru, Northern Tanzania

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Abstract

Characterisation of the aquifer and determination of its hydraulic properties is crucial for providing comprehensive knowledge for proper groundwater utilisation and management. This study delineates the aquifer structure using litho-hydrostratigraphy cross-sections and estimates the hydraulic parameters using single well pumping tests. The study found that, on the north-eastern and south-western flanks there are two aquifers: a shallow and a deep aquifer. On the north-eastern flank the shallow aquifer in some area is unconfined, composed of debris avalanche deposits, and in other area it is semi-confined or confined, composed of fractured and weathered lava with thickness more than 3 m, whereas the deep aquifer is composed of fractured and weathered lava with thickness of about 20 m. On the south-western flank the shallow aquifer is unconfined, composed of pyroclastic deposits with thickness more than 8.0 m, whereas the deep aquifer is composed of fractured and weathered lava with thickness of about 60 m. On the western flank the shallow aquifer is confined, composed of fractured and weathered lava with thickness more than 3.0 m. The hydraulic parameters on the north-eastern and western flanks were estimated based on one pumping test respectively, whereas on the south-western flank, they were estimated based on seven pumping tests performed at different locations. Results show that the transmissivity, hydraulic conductivity, storage coefficient and specific capacity for the shallow aquifer on the north-eastern, western and south-western flanks respectively are: $T = 0.464$ m\textsuperscript{2}/d, $K = 0.145$ m/d, $S = 0.049$ and $SC = 3.55$ m\textsuperscript{2}/d; $T = 0.438$ m\textsuperscript{2}/d, $K = 0.146$ m/d and $SC = 27.70$ m\textsuperscript{2}/d, and $T$ = average 7.85 m\textsuperscript{2}/d, $K$ = average 2.71 m/d, $S$ = average 0.40 and $SC$ = average 25.0 m\textsuperscript{2}/d. As we always consider SC as a rough measure
of T, most of the SC values are larger than T, indicating overestimated values, these are indicative values since the steady-state pumping conditions were not reached as the wells ran dry due to unsustainable pumping rates that exceed the aquifer transmissivity, except for one well where a steady-state pumping condition was nearly reached the values are quite similar. The shallow aquifer on the north-eastern and western flanks show similar hydraulic parameters, this suggests that the fractured and weathered lava has underwent a uniform weathering and fracturing, and thus forms a homogenous aquifer. The parameters on the south-western flank show high coefficients of variation: 78% for T, 91% for K, 88% for S and 67% for SC, which can be attributed to the aquifer heterogeneity. The shallow aquifer on the north-eastern and western flanks has potential for local water supply with limited consumption, whereas on the south-western flank, part of the aquifer has a potential for local water supply.

**Keywords:** groundwater flow; groundwater hydraulics; groundwater management; hydraulic properties; hydraulic testing; volcanic aquifer.