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How important are fractures for the fluid flow in a porous fractured sandstone aquifer?

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The main objective of the current study is to evaluate the importance of fractures for the overall flow behaviour in a porous fractured sandstone aquifer and the estimation of average in situ hydraulic apertures. Hence, fracture flow models were developed based on satellite images for the Wajid sandstone formation in Saudi Arabia. Data on fractures and lineaments were available for three outcrops. By applying a cut-out procedure on the fracture endpoint data of these large-scale fracture trace windows, three deterministic discrete fracture networks (DFN) with an area of 100 m x 100 m could be generated. The latter were used to simulate the fracture flow and to determine the effective hydraulic conductivity tensors. Using additional data on hydraulic pumping tests and matrix conductivities, in situ hydraulic apertures could be determined. Average in situ hydraulic apertures range from 1.3 to 1.7 mm. Field observations strongly support these results. In addition, a hydraulic conductivity ratio between the matrix and fracture system was used to identify the contribution of the DFN to the overall flow. A ratio of 10.4 was determined, which indicates that the effective flow behaviour in the Wajid sandstone aquifer is not entirely dominated by fractures, though evidently strongly controlled by it. Hence, the fracture systems have to be considered for the determination of the groundwater recharge and for the study of the flow behaviour of the Wajid sandstone aquifer.