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Flow pattern of low permeability zones in a fissured karst aquifer - 3-D flow model of the Marsaba-Feshkah area, Dead Sea

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The Marsaba-Feshkah area west of the Dead Sea can be defined as semi-arid to arid and suffers from an acute shortage of freshwater. Rainfall sharply decreases from the 500-700 mm in the western edge of the area to less than 100-150 mm along the Dead-Sea shore in the east. Previous studies indicated that substantial amounts of freshwater that penetrate the aquifer in the relatively rainy mountainous areas in the west flow eastwards to the Dead Sea where they mix with brines. The indication of this process is documented by the relatively high discharge of saline water in the Feshkah springs, which are the main outlet of the Cenomanian aquifers in this area. From the geologic situation the area is located in the eastern slopes of the Judea anticlinorium descending eastwards in a number of undulations that forms a set of parallel anticlines and synclines. The anticline structures are asymmetric, where the steep dip flanks descend to the east. The asymmetric structures are characterized by flexures crossing the area in northeast-southwest direction. The groundwater flow in the Upper and Lower Judea Group aquifers is from the recharge areas in the west towards the Feshkah springs in the east. From the western border up to Marsaba Anticline the Lower and Upper aquifers contain fresh water. Between Marsaba Anticline and the Dead Sea the Lower Aquifer contain brine. The fresh water flow is active only in the Upper Aquifer. The hydrogeological setting of study area is rather complex and suffers from a high de-

gree of uncertainty, due to a severe lack of data. A conceptual model and after that a computational three-dimensional flow model was constructed and calibrated until a satisfactory fit between measured and simulated data was established. Enhanced exploitation scenarios were chosen in order to find the favorable development scenario for this arid zone. The groundwater level differs between the western and eastern edges by 1100 m over a 30 km distance. This would mean an unfeasible average hydraulic gradient of 3%. This behavior of the hydraulic gradient can be explained only by a geological structure in the form of underground “cascades”. The cascades like structure is the result of the asymmetric geological structures crossing the area. Some research suggested that these cascades are a result of a deep reverse fault that folded the limestone-dolomite layers of the Cenomanian (and even younger formations) but do not fault them and do not reach to the surface. The flexure (cascade) divided the area into a number of secondary basins. The cascades are of low permeability, which causes a water level drop in the eastern lowermost areas of the flexure. The flow gradient in the uppermost areas of the flexure is relatively moderate. The major outlet of groundwater in the area is the Feshkah springs. There is probably some additional leakage of water through the rift fault into the basin fill sediments in the area north to the Dead-Sea. The size of the drawdown within each slice is affected by natural recharge in the slice itself, the pumping regime at individual wells, the total amount of extracted water and the distance between the wells.