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Understanding Tothian groundwater flow systems functioning for proposing adequate groundwater management in Mexico City

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The presence of water, in its surface and underground expressions, has played a vital role in the existence of the closed catchment of Mexico covering 9,600 km2; territory of ancient Mexico-Tenochtitlan that developed into the present Mexico City. Actions for desiccation of most of the original lakes since the XVII century have, however, been accompanied in finding suitable alternative water sources to comply with its development. Groundwater was struck when the first boreholes resulted artesian in the middle of the IXX Century. During the last 100 years groundwater has been an essential component in the development of the city, reaching now an estimated water usage in excess of 82 m3/s mainly from boreholes ≈400m deep tapping <10% of the total saturated thickness, producing a drawdown up to 50-70m in depth. The saturated thickness is in general represented by ≈650m of Quaternary sediments; ≈2,000m of a Tertiary fractured andesite-basalt sequence; ≈1,000m of karstic Cretaceous limestone; the later two are of regional extent and laying on an undetermined basement rock. Groundwater is meant to be administrated by managing the "Mexico City Aquifer, MCA", limited to a surface of only 2,103 km2 and to the well's depth. The computed groundwater availabilityof the MCA located within the southwest of the catchment has played a basic role in the development of Mexico City. Officially, the main groundwater source for the city is the MCA in which an accountancy of water is carried out through estimates applying the water-balance, where measurement of parameters is lacking, but assessed through calculations, water chemistry is excluded. Further, even with fully measured water-balance parameters the understanding of groundwater functioning would be deficient. As a feasible alternative the objective of the study was to reach a groundwater flow understanding of the Tóthian groundwater flow systems, as applied to the Metropolitan zone of Mexico City (CMZM), the base was their chemical and stable isotope signatures. The existing hydrogeological framework for the region provided a reference for such differentiation. Local flows (Flow-system I) represent the youngest and shallowest groundwater flow identified in wells on the hills. Intermediate flows (Flow-system II) in wells on the plain represent a mixture of inflows travelling horizontally, and vertically upwards (Flow-system IV) and downwards (from an overlaying aquitard leakage) to extraction wells. Flow-system III identified in wells on the plain is an intermediate flow system which travels deeper than Flow-system II. Flow-system IV, is classified as a regional system, and related to a former thermal spring site. Groundwater travelling times, and the regional distribution and thickness of related rock formations suggest extensive inflow supporting Flow-system IV. Future climate conditions evolution (i.e. drought) will only have a limited impact on Flow-system IV; as compared to Flow-system I which has relatively rapid and short flow-paths. The identification of flow-systems hierarchy is considered of importance to achieve an understanding groundwater flow functioning to achieve adequate management of water sources, mainly in any region where the aquifer-units are of several thousand meters thick and subject to shallow intensive abstraction.