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Magnetic resonance soundings as a tool to assess past and present groundwater recharge pattern in the Lake Chad basin

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Determining past and present surface water - groundwater interactions is challenging in flat sedimentary basins where small variations in the water balance may result in large changes in river courses or lake surface area. In semiarid sub-Saharan Africa, Lake Chad is an endorheic lake that remains fresh because of most of the lake water infiltrates to the aquifer. Large changes in the Lake surface area occurred during the Holocene and had an impact on aquifer recharge, yet little is known on past and present pattern of the aquifer hydrodynamics. Magnetic Resonance Sounding (MRS) is a method that allows non invasive determination of the free water content and hydraulic properties of aquifers. Two complementary MRS field surveys were conducted in the semiarid northwestern part of Lake Chad Basin in 2008 (11 soundings) and 2010 (12 soundings). High MRS water contents (10-35 %) and aquifer permeability values (10^{-3} to 10^{-2} m/s) were shown below present-day Lake Chad. At distance, below the former clayey deposits of the Megalake Chad, lower MRS water content (8-13 %) and permeability (10^{-4} to 10^{-3} m/s) values were estimated for the unconfined aquifer. These low porosity and permeability values suggest limited aquifer fluxes, in accordance with the occurrence of isotopically determined (O18/D) palaeo-groundwaters below the clayey plain. Intermediate and homogenous hydraulic properties (MRS water content and permeability values in the ranges of 16 to 25% and 1.10^{-3} to 3.10^{-3} m/s, respectively) were found in the Komadougou River valley, a seasonal river known by piezometric surveys to represent the main source of recharge for the aquifer. In the Lake Chad sedimentary basin, MRS revealed a distribution of aquifer hydrodynamics properties that depends on the distance to surface waters, and proved to be a decisive tool to quantify past and present surface water / groundwater exchanges.