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Relationships between sedimentary, diagenetic and tectonic structures to quantify karst groundwater reserves at the regional scale: Example of the Toulon area (South-east, France.)

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In the Mediterranean area, karst aquifers are important groundwater reserves nested in carbonate series that experienced complex tectonic and climatic histories. If it is commonly admitted that the sea level decreases during the messinian strongly conditioned the deep drainage of these aquifers through the development of an intense karstification, what heterogeneities (structural, sedimentary or diagenetic) in the carbonate series favored their development and explains the actual karst groundwater reserves? Situated at the boundary between the crystalline and the calcareous Provence, the Toulon area is characterized by a geological complexity typically influenced by several evolutions. Here we describe a multidisciplinary approach that couples structural and sedimentological analyses of carbonate series with the hydrogeological context. We integrate a refined diagenetic and fracturation sequence in a three-dimensional geomodeling (with GoCad code), to identify and quantify in three-dimensions the key geodynamic events that affect the porosity within the carbonate series. Field structural data inform us about a relation between karst development and faulting. Normal faults with pluri-hectometer offset were then reactivated in thrusts and strike slip faults, which conferred the major faults a several decameter thick core. Those faults were explored through different techniques: through balanced cross sections to reconstruct their geometry at depth and at the regional scale, with electric resistivity tomography to image the water content of the fault zone at the decameter to pluridecameter scale and with the analysis of the water hydrochemistry of springs outflowing from the fault zones to estimate their recharge potential. The hypothesis that we discuss is that the fault core made of breccia and/or cataclastic rocks was washed by paleofluid circulations initiating a large karstic network. Such fault cores may then represent both drainage and storage zones in the saturated zone of the deep aquifers. Detecting those cores as a function of fault geometry, size and offset could be a promising method to estimate karst reserves in highly tectonized areas.