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Determination of Aquifer Geometry Using Geophysical Methods: A Case Study from Sidi Bouzid Basin, Central Tunisia

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Abstract : Because of Sidi Bouzid water table overexploitation, this study aims at integrating geophysical methods to determinate aquifers geometry assessing their geological situation and geophysical characteristics. However in highly tectonic zones controlled by Atlassic structural features with NE-SW major directions (central Tunisia), Bouguer gravimetric responses of some areas can be as much dominated by the regional structural tendency, as being non-identified or either defectively interpreted such as the case of Sidi Bouzid basin. This issue required a residual gravity anomaly elaboration isolating the Sidi Bouzid basin gravity response ranging between -8 and -14 mGal and crucial for its aquifers geometry characterization. Several gravity techniques helped constructing the Sidi Bouzid basin's residual gravity anomaly, such as Upwards continuation compared to polynomial regression trends and power spectrum analysis detecting deep basement sources at (3km), intermediate (2km) and shallow sources (1km). A 3D Euler Deconvolution was also performed detecting deepest accidents trending NE-SW, N-S and E-W with depth values reaching 5500 m and delineating the main outcropping structures of the study area. Further gravity treatments highlighted the subsurface geometry and structural features of Sidi Bouzid basin over Horizontal and vertical gradient, and also filters based on them such as Tilt angle and Source Edge detector locating rooted edges or peaks from potential field data detecting a new E-W lineament compartmentalizing the Sidi Bouzid gutter into two unequally residual anomaly and subsiding domains. This subsurface morphology is also detected by the used 2D seismic reflection sections defining the Sidi Bouzid basin as a deep gutter within a tectonic set of negative flower structures, and collapsed and tilted blocks. Furthermore, these structural features were confirmed by forward gravity modeling process over several modeled residual gravity profiles crossing the main area. Sidi Bouzid basin (central Tunisia) is also of a big interest cause of the unknown total thickness and the undefined substratum of its siliciclastic Tertiary package, and its aquifers unbounded structural subsurface features and deep accidents. The Combination of geological, hydrogeological and geophysical methods is then of an ultimate need. Therefore, a geophysical methods integration based on gravity survey supporting available seismic data through forward gravity modeling, enhanced lateral and vertical extent definition of the basin's complex sedimentary fill via 3D gravity models, improved depth estimation by a depth to basement modeling approach, and provided 3D isochronous seismic mapping visualization of the basin's Tertiary complex refining its geostructural schema. A subsurface basin geomorphology mapping, over an ultimate matching between the basin's residual gravity map and the calculated theoretical signature map, was also displayed over the modeled residual gravity profiles. An ultimate multidisciplinary geophysical study of the Sidi Bouzid basin aquifers can be accomplished via an aeromagnetic survey and a 4D Microgravity reservoir monitoring offering temporal tracking of the target aquifer's subsurface fluid dynamics enhancing and rationalizing future groundwater exploitation in this arid area of central Tunisia.

Keywords : aquifer geometry, geophysics, 3D gravity modeling, improved depths, source edge detector
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