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3D structure of a complex of transform basins from gravity data, a case study from the central Dead Sea fault

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The Kinneret-Bet She'an (KBS) basin complex comprises the Sea of Galilee, Kinarot, and Bet She'an sub-basins. The complex developed at the intersection between two major tectonic boundaries: the Oligo-Miocene Azraq-Sirhan failed rift, that later developed into the southern Galilee basins and Carmel-Gilboa fault system; and the Dead Sea fault (DSF) plate boundary that developed since the Miocene. Despite numerous studies, KBS still remains one of the enigmatic basin complexes. Its structure, stratigraphy and development are vaguely understood – both inside the basin and in correlation with its surroundings. Our study presents a new and comprehensive 3D model for the structure of KBS complex. It is based on all available gravity measurements, adopted from the national gravity database, and new gravity measurements, collected in cooperation with the Geological Survey of Israel and funded by the Ministry of National Infrastructure, Energy and Water Resources. The gravity data were integrated with constraints from boreholes, surface geology, seismic surveys, potential field studies and teleseismic tomography. The dense distribution of gravity data [1] provides suitable coverage for modeling the deep structure in three dimensions. The model details the spatial distribution, depth, thickness and density of the following regional units within the KBS complex and across its surroundings: upper crust, pre-Senonian sediments, Senonian and Cenozoic sediments, Miocene volcanics, Pliocene and Quaternary volcanics. Additional local units include salt, gabbro and pyroclasts. Results indicate that the KBS complex comprises two sub-basins separated by a structural saddle: Kinneret-Kinarot (∼6-7 km deep, ∼45 km long) and Bet She'an (∼4 km deep, ∼10 km long) sub-basin. A 500 m thick layer of Miocene volcanics appears across the Bet She'an sub-basin, yet missing from the Kinneret-Kinarot sub-basin. Between the basins Zemah-1 borehole penetrated a salt unit. The model indicates that this unit is a part of a thick (1250 m) dome-shaped, perhaps diapiric, structure. A relatively thin (350 m) salt unit fills the Kinneret-Kinarot sub-basin. Above, a 700 m thick layer of Pliocene volcanics fills the entire KBS complex. These volcanics are uplifted in the Zemah area by ∼200 m. The Pliocene volcanics dip northward from Zemah towards the center of the Sea of Galilee, and further north the Pliocene volcanics dip southward from Korazim towards the center of the Sea of Galilee. The depth differences exceed 3 km across a distance of ∼15 km, forming a ∼11° slope below the younger Quaternary fill of the basin. A low-density, probably pyroclastic, lens is calculated within the uppermost 2 km of the Sea of Galilee fill. Scenarios for the development of the basin are discussed.

[1] Rosenthal, M., Segev, A., Rybakov, M., Lyakhovsky, V. and Ben-Avraham, Z. (2015) The deep structure and density distribution of northern Israel and its surroundings. GSI Report No. GSI/12/2015, 33 pages, Jerusalem.