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Gravity anomalies over Orinoco Oil Belt

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The Orinoco Oil Belt (OIB) is one of the largest heavy oil reservoirs of the world. In the last years, significant efforts have been made to articulate technical capabilities of different nations. These strategic alliances with Venezuela's state oil company, allow the certification of the reserves, and further enhancing capabilities required for oil extraction. This situation contributes to meet the global demand for heavy crude in the near future.
The OIB is subdivided into four blocks (from west to east): Boyacá (BB), Junín (JB), Ayacucho (AB) and Carabobo (CB), totaling an area of 55,314 km^2. The first two blocks are located on the southern flank of the "Guárico Sub-Basin" (GSB), while the last two are located on the southern flank of the "Maturin Sub-Basin" (MSB). The geology of the area can provide important differences in the basement of the four blocks, with a tendency to increase the basement depth from west to east, with dominant patterns of normal faults oriented NE-SW (Altamira, Hato Viejo). This work presents an interpretation of Bouguer anomalies (BA) over the OIB, as well as regional and residual components, obtained from the gravitational spectral analysis. In the eastern portion of the Bouguer Anomalies map "BA-map" (extracted from the blocks AB and CB) dominant trends can be observed, with preferred orientation N72°E. These trends are controlled by the depocenter of the MSB, obtaining values of BA between -11 and -172 mGal, while in the North-South an average gradient of 1.84 mGal/km can be obtained from the sampled region. The lateral contrast of gravity gradients is associated with variations in the basement depth, due to the differential development of the MSB southern flank. It can be highlighted the highest penetration of Guiana Craton rocks formation at the OIB 's eastern boundary.
The western segment of the BA-map (blocks BB-JB) reveals a shallowest basement depth with BA values: between -32 to 41 mGal and North-South gradient average of 0.59 mgal/km. In addition, the gravity contours with NE-SO preferred orientation presents a lower angle than the eastern segment. The basement in the OIB is represented on the west by the eastern extension of the "Baúl High " formation, characterized by significant lateral contrasts in depth and direction. The north of the OIB is characterized by the presence of the "Espino Graben" and the development of a negative BA in the southern limit of the Altamira Fault, associated with prolongation of the depocenter of the MSB.
At the southern boundary of the four blocks, the basement highs/lows have NW-SE main orientation; while in the OIB central and northern section, the basement alterations are oriented NE-SW with similar angles to the basement preferred orientation of the western section (BB-JB). This orientation is dominated by the Hato Viejo and Altamira regional fault systems.
The gravimetric response in a shallow basement area requires of residual BA to establish the relation between well data or seismic surveys. The residual BA-map for OIB supports the following findings:
The deepening of the basement to the northeastern part of the study area (with a clear delineation of blocks) isolates the basement highs/lows of each block.
The qualitative interpretation of regional and residual BA of the OIB, suggests the deepening of the basement top in SW-NE direction. The analysis of residual BA allows the recognition of different stress patterns in the formation of the basin that imply different stages of formation.
The gravitational response, of the regional geological structures, that involve basement is related with an extensive tectonic regime. However, the observed correlation between the residual BA, and the basement-involved geological structures (previously interpreted), suggests the presence of compressive and extensive stresses, and the possible generation of syntectonic structures.
The sequence of basement highs/lows revealed in the residual BA-map is closely related to the basement map data, derived from wells and seismic surveys. This resulting sequence, enable the research community to report data in areas where there are not such studies in previous efforts. Similarly, it allows to have a continuous image of the basement variations in the area of study.