Preliminary gravity characterization of the Nova Colinas impact structure, Parnaíba basin, Brazil: Implications for hydrocarbon accumulation

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This paper was prepared for presentation during the 18th International Congress of the Brazilian Geophysical Society held in Rio de Janeiro, Brazil, 16-19 October 2023.
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Abstract

The Nova Colinas structure is the newest confirmed complex impact structure in Brazil, making it the ninth of its type known in the country. It is located in the Parnaíba sedimentary basin, in SW Maranhão State. This nearly circular structure has its center at 7º9'33" S and 46º6'30" W and a diameter of approximately 7 km, with an estimated age between 200-250 Ma based on stratigraphic constraints. Shock deformation features found at NC include planar fractures and planar deformation features in quartz, as well as shatter cones. NC is one of the rare examples on the Earth's surface of a meteoritic impact structure formed in mixed volcanic-sedimentary rocks. As the volcanic rocks comprise basalt, the study of NC may provide, by analogy, valuable insights for characterizing planetary geological processes, once basalt is a predominant lithology in planetary bodies such as the Moon, Mars, among others. Geological phenomena related to crater formation processes, such as fracturing, brecciation and hydrothermal alteration, can promote the buildup of hydrocarbon deposits. Impact structures with diameters similar to NC, such as Calvin (D=6.1 km) and Red Wing Creek (D=9.1 km), both located in the USA, are well-documented impact structures with associated hydrocarbon accumulations. Geophysics has been playing a fundamental role in identifying and interpreting the subsurface characteristics of large impact structures that, in turn, are important for analyzing the potential for oil and gas accumulations. A comprehensive geophysical characterization of the NC impact structure is underway, including the analysis of magnetometric, seismic and gravity data. Here, we discuss the results of a preliminary gravimetric characterization of NC. We compared Bouguer anomaly maps with different density slabs aiming to reduce the topographic effect on the collected data. A previous work shows that a density of 2,05 g/cm³ would fit better than the standard slab of 2,67 g/cm³ for this region. The final Bouguer maps show similar results in terms of intensity and geometry of the anomalies. The results allowed a clear distinction between two different domains in the structure: (i) one in the NE area exhibiting a high gravity peak of -77.4 mGal, probably related to the basalt of Mosquito Formation, and (ii) another in the SW area with lower gravity values reaching -86.5 mGal, likely related to the sandstones of Sambaíba Formation. Although the structure's boundaries are not well defined by the Bouguer anomaly, it exhibits a nearly circular anomaly in the central area with a high gravity of approximately -78.8 mGal, likely related to a central structural uplift. Due to the impact-related (shock) effects on the target rocks, it is expected to exhibit a central low gravity signature typical of complex craters, which does not occur at NC. A reasonable explanation for the lack of the low gravity anomaly at the center is related to the intrusions of diabase sills within the lower clastic sedimentary sequences during the Mosquito volcanic event. These sills were then uplifted at the center, being placed close to the surface, or partially exposed.