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Integrated Geophysical Surveys for Sinkhole and Subsidence Vulnerability Assessment, in the West Rand Area of Johannesburg

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Abstract : The recent surge in residential infrastructure development around the metropolitan areas of South Africa has necessitated conditions for thorough geotechnical assessments to be conducted prior to site developments to ensure human and infrastructure safety. This paper appraises the success in the application of multi-method geophysical techniques for the delineation of sinkhole vulnerability in a residential landscape. Geophysical techniques ERT, MASW, VES, Magnetics and gravity surveys were conducted to assist in mapping sinkhole vulnerability, using an existing sinkhole as a constraint at Venterspost town, West of Johannesburg city. A combination of different geophysical techniques and results integration from those proved to be useful in the delineation of the lithologic succession around sinkhole locality, and determining the geotechnical characteristics of each layer for its contribution to the development of sinkholes, subsidence and cavities at the vicinity of the site. Study results have also assisted in the determination of the possible depth extension of the currently existing sinkhole and the location of sites where other similar karstic features and sinkholes could form. Results of the ERT, VES and MASW surveys have uncovered dolomitic bedrock at varying depths around the sites, which exhibits high resistivity values in the range 2500-8000ohm.m and corresponding high velocities in the range 1000-2400 m/s. The dolomite layer was found to be overlain by a weathered chert-poor dolomite layer, which has resistivities between the range 250-2400ohm.m, and velocities ranging from 500-600m/s, from which the large sinkhole has been found to collapse/ cave in. A compiled 2.5D high resolution Shear Wave Velocity (Vs) map of the study area was created using 2D profiles of MASW data, offering insights into the prevailing lithological setup conducive for formation various types of karstic features around the site. 3D magnetic models of the site highlighted the regions of possible subsurface interconnections between the currently existing large sinkhole and the other subsidence feature at the site. A number of depth slices were used to detail the conditions near the sinkhole as depth increases. Gravity surveys results mapped the possible formational pathways for development of new karstic features around the site. Combination and correlation of different geophysical techniques proved useful in delineation of the site geotechnical characteristics and mapping the possible depth extend of the currently existing sinkhole.

Keywords : resistivity, magnetics, sinkhole, gravity, karst, delineation, VES
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