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# Structural analysis of Jwaneng Mine, Botswana

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Jwaneng Mine, in south-central Botswana, is host to at least four kimberlite diatremes that currently contain the single largest in-situ concentration of diamonds worldwide, contributing over 50% of the country's income. An understanding of the structural setting and history of Late Archaean to Early Proterozoic host sediments, is essential for their safe, economic extraction. This requires the ongoing construction of fully-constrained 3D geological models of the country rock, which in turn requires a robust structural interpretation based on pit mapping, geotechnical drilling and geophysical data. This exercise provides a rare insight into the tectonic evolution of this part of Botswana, which is particularly significant due to the lack of outcrop within deep, laterally extensive sand and calcrete of the Kalahari Sequence or Group.

In the Kanye Basin, Griqualand West sediments overly Archaean basement, predominantly comprising the Gaborone Granite Suite and Kanye Formation rhyolite. An early compressional, NW- to NNW-directed or verging, fold-and-thrust event, which affected the sediments, is termed $D_1$ in accordance with available regional studies and data. This event produced NW- to NNW-directed, low-angle thrusts, which run into parallelism with adjacent bedding. Breached anticline-syncline structures indicate that the cumulative strain, characterized by low-angle thrusts, was distributed throughout the entire sequence and was substantial. Where thrusting has not developed, the early compressional event produced a weakly fanning axial planar cleavage in broad, open folds. Dolerite sills preferentially exploited stepped paths, comprising a combination of thrusts and bedding.

$D_2$ may have comprised NE-SW-directed compression, resulting in oblique sinistral movement along axial planar cleavages of $F_1$ folds. This event also produced very broad or open, NW-SE-trending $F_2$ folds, with wavelengths of approximately 400m. The weakly fanning axial planar cleavage was re-utilized as a series of tensional joint sets, subsequently developing into steeply-to moderately SE-dipping normal faults during an extensional $D_3$ event.

Major, SE-dipping normal faults, predominantly those that show an ENE or 070° trend, were confirmed by pit mapping, macrostructural logging of geotechnical drillholes and downhole televiewer data. These structures subdivide the volume of interest (VOI) into fault-bounded blocks, each with a systematic bedding orientation. The effects of deformation are incorporated into a detailed 3D country rock model for geotechnical design. A total of 64 faults were modelled in Leapfrog Geo™, of which 21 comprise block-bounding faults. A total of 45 second-order faults were also created, in a model that extends to 500m beyond the Cut 9 design and to a depth of 1500mbc. At least one steeply N-dipping normal fault is interpreted from several deep drillholes that show extreme downthrow of the upper Malmani dolomite contact to the northwest of the mine. The approximate central part of the VOI therefore shows a fault-bounded horst, which narrows to the northeast, with the three main kimberlite diatremes situated on or close to its southeastern flank. Bedding dip decreases systematically from NW to SE, away from the southern flank of this modelled horst, hinting at the presence of an extensional roll-over structure.