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Structural Setting and Geometry of the Leeuwfontein Deposit, Kolomela Mine, South Africa

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Leeuwfontein, at the southern extent of the Maremane Dome, is one of the main deposits of the Kolomela Iron Ore mine in the Northern Cape. The region exhibits a protracted, complex series of geological events, from initial Ventersdorp rift basin development at 2.78 Ma to the Lomanian (Namaqua-Natal) orogeny, ending at ca. 1.0 Ga. This contribution examines the geometry and setting of the deposit in light of its protracted structural history.

Rift development at ca. 2.60-2.46 Ga resulted in NE-SW fault formation and the development of a carbonate platform. Rifting was accompanied by hydrothermal deposition of manganiferous chert of the Wolhaarkop Formation and subsequent deposition of the important Asbestos Hill Subgroup banded iron formations. Rifting was succeeded by additional "E_1" extension, followed by the Kalahari Orogeny at ca. 2.35-2.25 Ga which produced the first phase of folding (F_1) and thin-skinned thrusting, accompanied by inversion of pre-existing, rift-related normal faults and strike-slip movement along conjugate NE- and SE-trending strike-slip faults. Associated uplift and erosion resulted in the formation of the Gamagara Unconformity which is pivotal in regional ore development and/or preservation. Erosion was followed by fault re-activation and the development of the volcanosedimentary/volcaniclastic Upper Postmasburg Group, with Ongeluk lavas signifying the peak of mafic lava extrusion at ca. 2.22 Ga. Around this time, gabbro intruded into the Ghaap and Postmasburg Groups within NE-trending grabens, forming a significant feature of the Leeuwfontein deposit. Deposition of reworked quartzites, "grits" and conglomerates of the Gamagara/Mapedi Formation occurred at ca. 2.05-1.93 Ga. A second extensional event or "E_2" occurred during or shortly after this period, with reactivation of normal faults. Extension was followed by the ca. 1.83-1.73 Ga Kheis Orogeny which similarly showed eastward tectonic vergence and thin-skinned thrusting, with F_2 folds co-axially tightening F_1 folds. The ca. 1.15-1.0 Ga NNW-directed Lomanian Orogeny comprised the last major deformational event; reactivating, segmenting and buckling N-S trending normal and inverted normal faults, reactivating 2.35-2.24 Ga NE- and SE-trending conjugate strike-slip faults - usually with an upthrow to the SE and SW, respectively - and producing broad ENE-trending F_3 folds.

The combined effects of these deformation events, which are typified by the Leeuwfontein Deposit, are resolved by high-quality drilling, pit mapping over the course of 3 years and implicit 3D modelling in Leapfrog™: 1) relatively downthrown ore preserved in a relict, deposit-scale, sub-basin, graben or half-graben structures, bound by partially inverted normal faults that are flanked by high-energy sediments, including conglomerate, hematite-rich conglomerate and intercalated shale; 2) low-angle, SE- and NW-verging, thin-skinned thrusting, with local duplication, blind thrusts, breached folds and local tectonic introduction of graphitic shale and dolomite into BIF; 3) NNE-SSW-trending folds, with varying

amplitudes, parallel to the graben; 4) reactivated NW-SE-trending component of the abovementioned conjugate fault set, in the form of a subvertical strike-slip fault that transects and dextrally displaces the entire orebody and its host sub-basin/graben/half-graben geometry. Although locally fault-bounded, a laterally extensive, thick, low-angle, bedding-parallel or thrust-parallel gabbro body underlies the main laminated and massive orebody, which is locally separated from the latter by thin slivers or remnants of banded iron formation. The northern half of Leeuwfontein is host to a distinct palaeosinkhole, which is overlain by anomalously thick Gamagara shale and Kalahari sediments.