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Regional to Licence-Scale Structural Controls Derived from Structural Mapping, Geophysical Analysis, and 3D Modeling of New Luika Gold Mine, Lupa Terrane, SW Tanzania

Corné Koegelenberg[1, 3], Jonathan N. Gloyn-Jones[1], Ian J. Basson[1, 3], Paul W. Mbuya[2], Alfred M. Kulwa[2], Shineni Ramadhani[2], Dustan Daud[2]
1. Tect Geological Consulting, Somerset West, South Africa, 2. Shanta Gold, Dar es Salam, Tanzania, 3. Stellenbosch University, Stellenbosch, South Africa

The Lupa Goldfields and encompassing Paleoproterozoic Lupa Terrane in southwestern Tanzania is known for its high prospectivity and is host to numerous artisanal gold mines and several relatively small- to medium-scale gold deposits that range broadly between 150 and 4,000 kt at 1.5–5 g/t Au. Shanta Gold's New Luika Mine is currently the largest open and underground mine within the Lupa Goldfields and comprises at least 10 different deposits over an area of 18 km^2 with a combined resource of 1,105 koz at 2.56 g/t Au (2021). However, despite the conspicuous prospectivity of the region, comparative recent discoveries or extensions to known high-grade (>4 g/t) deposits has been elusive. The Lupa Terrane predominantly comprises a suite of Archaean granitiods (ca. 2.74 Ga) intruded by Palaeoprotrozoic granites and gabbrodiorites (ca. 1.96 Ga) that reflect reworking of the southern margin of the Tanzania Craton during protracted deformation of the Ubendian Orogeny (2.1–1.88 Ga). Relatively late-tectonic auriferous quartz veins account for economic mineralization (ca. 1.88) Ga within narrow, mostly ductile, mylonitic shear zones developed under greenschist metamorphic conditions. From a regional- to deposit-scale, mylonite zones are generally continuous and interconnected, which emphasizes an extensive, structurally controlled fluid conduit system. However, along these mylonite zones and away from known deposits, surface exploration records increasingly variable and often discontinuous along-strike auriferous mineralization, which suggests that new deposits or deposit extensions are likely not exposed on surface but hidden at greater depths.

To advance the understanding on the structural controls on mineralization, this contribution presents a regional- to deposit-scale structural analysis that integrates aeromagnetic, field mapping, drill hole, and soil geochemistry data over New Luika Mine and surrounding areas. Deposit-scale, fault-fill, auriferous vein systems and associated mylonite fabrics are structurally and kinematically described and modeled in 3D, with the aim of establishing the structural controls on fluid flow and associated auriferous mineralization.

Results depict a 1^{st}-order or regional network of wide, incipient to intensely strained, oblique, left-lateral (transpressional-) shear zones (or "shear zone corridors"), which act as mineralized fluid conduits across several tens of kilometres. These shear zone corridors host well-developed, deposit-scale 2^{nd}- to 3^{rd}-order mylonite zones that are mineralized, to between ca. 1 and 3 g/t Au. Increased structural dilation and silicification along 2^{nd}- to 3^{rd}-order mylonite zones within $^{1)}$ 1^{st}-order release bends and/or $^{2)}$ that are unfavourably orientated with respect to the regional stress configuration exhibit increased auriferous grades (ca. 2-5 g/t Au). More locally, a combination of favourable kinematics, variable rock rheology, and/or the reactivation of preexisting contacts or structures cause steep- to shallow-plunging mesoscale release bends on 2^{nd}- to 3^{rd}-order mylonites further accounting for highly mineralized (>6 g/t Au) ore-shoot formation. Exploration following this rationale has significantly added to the resource at New Luika Gold Mine, while also providing a framework for regional exploration in the Lupa Goldfields, thereby reemphasising the value of careful structural analysis in such structurally convoluted terranes.

Figure: Structural architecture and kinematics of the main shear zone corridor encompassing New Luika, Luika South, and Bauhinia Creek Deposits.