Paper Number: 1397

Structural control of fluid flow and Fe deposition at Thabazimbi Mine: Insights from mapping and 3D modelling of operational pits

Basson, I.J.[1, 2], Koegelenberg, C.[1]

[1] Tect Geological Consulting, Unit 8, AMDEC House, Steenberg Office Park, Tokai, South Africa
[2] Department of Earth Sciences, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa

---

Chemo-sedimentary rocks of the Transvaal Supergroup have been folded and imbricated during formation of the Mohlapitsi fold-and-thrust Belt (MB). Several high-grade (>63% Fe), stratiform iron ore deposits are constrained to the base of the banded iron formation (BIF)-dominated Penge Formation, which forms a distinct, E-W-trending marker horizon in the Northern- and Southern Ranges. The Penge Formation is separated from the underlying Malmani dolomite by a thin, laterally continuous and rheologically weak carbonaceous or graphitic shale layer that has been intensely sheared and tectonized. This horizon defines a regional, top-to-N, low-angle detachment (thrust). Several of Kumba's Thabazimbi iron deposits, including Kwaggashoek East, Donkerpoort West, Kumba-Donkerpoort West and Buffelshoek West, are restricted to a zone directly above this detachment.

Recent ore petrography and analysis of associated fluid alteration, fluid composition and stable isotope geochemistry have clearly linked economic Fe mineralization with hydrothermal processes (i.e. hypothermal). This, along with localized, high-grade mineralization suggest a structural control on fluid flow, although a paucity of structural data has thus far hampered more concise mineralization models. In this study we present detailed structural mapping and analysis of drillholes via intergraded 3D models of each deposit at Thabazimbi discussing, *inter alia,* the structural characteristics and signs of associated fluid flow. We further discuss the possible timing of mineralization and the regional implications for fluid flow in the context of regional events.

Data and models indicate that structural control of fluid flow, and thereby ore formation, may be associated with significant fold amplification and increased localized flexural bending along the E-W trending dolomite-BIF detachment. Subsidiary fold-accommodation structures such as conjugate shear joints, normal faults, reverse faults and thrusts, appear to be associated with a degree of inner- and outer-arc shortening and extension, respectively. These locally aided and compartmentalized fluid flow along and around the detachment. In addition, ore-grade mineralization occurs at the intersection of major reverse faults, at the detachment and in stratigraphically higher, low-angle thrusts that are developed preferably at diabase-BIF contacts. Preservation of ore was locally enhanced by late, NW- to NNW-trending, Mesozoic (D_4) normal faulting and downthrow of fault-bounded blocks.

Regional top-to-the-N kinematics and vergence of (F_2) folds accompanies mineralization during the main fold-and-thrust event (D_2) of the MB and hints at the Belt-of-Hills and Bobbejaanwater Thrusts acting as significant regional fluid conduits, which channelled fluids into secondary structures. Although the exact timing of deformation is not clear at present, regional structural relationships suggest that D_2 shortening occurred during, or at least shortly after, intrusion of the Bushveld Complex.