Mineralium Deposita
https://doi.org/10.1007/s00126-017-0784-y

ARTICLE

3D implicit modeling of the Sishen Mine: new resolution of the geometry and origin of Fe mineralization

B. Stoch[1] · C. J. Anthonissen[1] · M-J. McCall[1] · I. J. Basson[1,4] · J. Deacon[2] · E. Cloete[2] · J. Botha[2] · J. Britz[3] · M. Strydom[3] · D. Nel[3] · M. Bester[3]

Received: 12 April 2017 / Accepted: 4 December 2017

Abstract
The Sishen deposit is one of the largest iron ore concentrations in current production. Hematite mineralization occurs along a strike length of 14 km, with a width of 3.2 km and a maximum vertical extent of 400 m below the original surface. The 986-Mt reserve incorporates a suite of individual orebodies, beneath a locally preserved tectonized unconformity, with a wide range of geometries, depths, and orientations. Fully constrained, implicit 3D modeling of the entire mining volume (> 70 km^3), was undertaken to the original, pre-mining topography. The model incorporates 5287 mapping points and > 21,000 drillholes and provides exceptional insight into the original configuration of ore and its relationship to contacts, unconformities, and structures in the enclosing country rock. The bulk of ore occurs to the west of a strike-extensive, partially inverted normal fault (Sloep Fault), within an asymmetrical synclinal structure on its western flank. This linear, N-S distribution of deep, thick ore is punctuated by palaeosinkholes, wherein base-of-ore dips of greater than 45°, are concentrically arranged. Localized ore volumes also occur along faults and in fault-bounded, downthrown blocks, to the north of NW-SE- and NE-SW-trending strike-slip faults that show relatively minor uplift to the south, probably due to the Lomanian Namaqua-Natal Orogeny. The revised model demonstrates the proximity of ore to a tectonized unconformity and highlights the structural control on ore volumes, implying that Fe mineralization at Sishen cannot be exclusively attributed to supergene enrichment and concentric palaeosinkhole formation.

Keywords Iron ore · Structural interpretation · Implicit modeling · Leapfrog™

Introduction

Mined since 1953, Sishen Mine near the town of Kahtu in the Northern Cape Province (RSA) represents one of the largest high-grade iron ore deposits globally. It consists of a series of large hematite bodies with a cumulative strike length of approximately 14 km, a width of 3.2 km, and a maximum depth of 400 m. This encompasses a 434-Mt exclusive mineral resource and a 552-Mt (Fe grade > 58%) ore reserve (as of 31 December 2016), spanning three mining areas (North, Middle, and South Mine) and five sub-pits (Vliegveld, Dagbreek-Watergat, GR35, GR50, and GR80). Mining focuses on high-grade (Fe ≥ 61%) and medium-grade (Fe ≥ 40%) hematitic mineralization hosted by a thick sequence of chemical and clastic sediments of the Transvaal Supergroup in the Griqualand West Basin.

The deposit is situated at the northern end of a range of hills, with 60 km of strike extent, along the western limit of the Maremane Anticline or Maremane Dome, which occurs near the western margin of the Kaapvaal Craton (Van Schalkwyk and Beukes 1986). This dome exposes, and is rimmed, by lithologies of the Griqualand West Basin and Olifantshoek Supergroup (Fig. 1). The bulk of laminated and massive ore is concentrated within the Kuruman Formation, which is the

Editorial handling: S. Hagemann

✉ B. Stoch
benstoch@tect.co.za

[1] Tect Geological Consulting, Unit 3, Metrohm House, Gardner Williams Avenue, Paardevlei, Cape Town, South Africa

[2] Sishen Iron Ore Company (Pty) Ltd., Private Bag X506, Kathu 8446, South Africa

[3] Kumba Iron Ore, Corporate Office, Centurion Gate, 124 Akkerboom Road, Centurion 0157, South Africa

[4] Department of Earth Sciences, Stellenbosch University, Private Bag X1, Matieland, Stellenbosch 7602, South Africa

Published online: 20 December 2017