

Gold Mineralization in High-Grade Metamorphic Shear Zones of the Renco Mine, Southern Zimbabwe

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Abstract

The Renco gold mine in southern Zimbabwe is the only known major gold deposit in the granulite facies terrane of the northern marginal zone of the Late Archean to mid-Proterozoic Limpopo belt. Gold mineralization is confined to a system of high-temperature mylonite zones characterized by two distinct geometries. These include a series of shallow southeasterly dipping, anastomosing, north-northeast- to east-northeast-trending tabular lodes, termed “shallow reefs,” and subvertically inclined, shallow easterly plunging pipelike lodes, termed “steep reefs.” The kinematics and orientation of the mineralized shear zones are consistent with a lateral and frontal thrust zone geometry that formed during the Late Archean thrusting of the northern marginal zone onto the Zimbabwe craton. Gold is spatially and temporally closely associated with sulfide mineralization, including pyrrhotite as the dominant sulfide with minor amounts of chalcopyrite and pyrite. Associated wall-rock alteration comprises a garnet-biotite-quartz \pm siderite mineral assemblage. Mineral textures within the host mylonites, as well as garnet-biotite thermometry, indicate gold deposition at temperatures of about 600°C under mid-amphibolite conditions, slightly postdating regional peak metamorphic conditions. Fluid flow in the high-temperature shear zones was largely controlled by fracture permeabilities. Transient episodes of brittle fracturing during conditions of close to lithostatic fluid pressures were promoted by a pronounced strain partitioning within the narrow shear zones into ductile mylonite bands and brittle-ductile “lithons” that contain the bulk of the gold sulfide mineralization. The high-grade metamorphic ore and alteration mineral assemblages are overprinted by lower greenschist facies parageneses along brittle faults and cataclasites that are related to the mid-Proterozoic tectonism of the northern marginal zone. It is concluded that the mineralization at Renco illustrates the rare case of a midcrustal high-grade metamorphic gold mineralization in southern Africa where the vast majority of Late Archean lode gold deposits are related to low-grade metamorphic granite-greenstone terranes.

Introduction

IN CONTRAST to the vast majority of lode gold deposits in Zimbabwe that are associated with Late Archean greenschist facies granite-greenstone terranes of the Zimbabwe craton, the Renco mine is one of the very few economic-grade gold deposits hosted outside the realms of the Zimbabwe craton. The Renco mine is located in southern Zimbabwe, approximately 75 km southeast of Masvingo in the northern marginal zone of the Late Archean to mid-Proterozoic Limpopo belt (Fig. 1) situated in granulite facies enderbites and charnockites of predominantly tonalitic to granitic composition. It is the most prominent gold mineralization of a number of discontinuous, small-scale prospects in the region known as the Nyajena gold field that covers an area of ca. 15 km². Currently, the Renco mine is the second largest gold producer in Zimbabwe. The average grade approximates 5.5 g/t Au and the annual production amounts to 1.5 t Au in an underground operation.

Over the past years, the geology, origin, and timing of gold mineralization at Renco have been a matter of conjecture and several genetic models have been proposed, including (1) a sedimentary, placer-type origin of the gold mineralization subsequently subjected to high-grade metamorphism and intense deformation (Böhmke and Varndell, 1986), (2) a structurally controlled mineralization in a refolded shear zone system that formed under greenschist facies conditions (Tabcart, 1987, 1988, 1989), and, most recently, (3) a polyphase mineralization

mainly emplaced during the mid-Proterozoic tectonism and greenschist facies overprint of the northern marginal zone at ca. 2.0 Ga (Blenkinsop and Frei, 1996). Although the epigenetic, shear zone-hosted origin of the Renco mineralization is widely accepted now, complex overprinting relationships of ore and alteration minerals and deformational styles have given rise to a debate about the conditions and, thus, timing of the gold mineralization (Böhmke and Varndell, 1986; Tabcart, 1989; Frei, 1995; Blenkinsop and Frei, 1996; Kempen et al., 1997; Kisters et al., 1997a, b; Kolb et al., 1997). The main point of conjecture hinges on the question of whether gold mineralization occurred during the low-grade metamorphic tectonism at ca. 2.0 Ga (Tabcart, 1989; Frei, 1995; Blenkinsop and Frei, 1996), or whether the greenschist facies metamorphism and associated brittle deformation postdate the gold mineralization, merely overprinting a Late Archean, high-grade metamorphic gold mineralization (Mikucki and Ridley, 1993; Kisters et al., 1997a, b; Kolb et al., 1997). This question has important implications for gold exploration in the high-grade granite gneiss terrane of the northern marginal zone because it suggests the existence of possible midcrustal equivalents of the mainly greenschist facies, upper crustal lode gold deposits in southern Africa, a scenario similarly described for lode gold deposits from other Archean cratons (e.g., Groves et al., 1990; Barnicoat et al., 1991; Bloem et al., 1994).

This study presents new data on the structural and petrographic evolution of the gold mineralization at the Renco mine emphasizing, in particular, the geometry and kinematics of the mineralized shear zone system. In addition, textural

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